PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	**Zhang et al**
Application No.:	**10/827494**
Filed:	**April 19, 2004**
For:	**IMPROVED CATHETER BALLOON MOLD FORM AND MOLDING PROCESS**
Examiner:	**Monica Anne Huson**
Group Art Unit:	**1791**

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Docket No.: S63.2B-11346-US01

APPEAL BRIEF

This is an Appeal Brief for the above-identified application in which pending claims 2-22 were rejected in the Final Office Action dated **September 17, 2007**.

A Notice of Appeal, with a two-month extension petition, was filed in this case on February 19, 2008.

The Commissioner is authorized to charge Deposit Account No. 22-0350 for any other fees which may be due with this Appeal Brief.

(i) Real Party in Interest

The Application is assigned to Boston Scientific Scimed, Inc., formerly known as Scimed Life Systems, Inc., One SciMed Place, Maple Grove, Minnesota 55311-1566, a Minnesota corporation and a subsidiary of Boston Scientific Corporation, One Boston Scientific Place, Natick, Massachusetts 01760-1537, a Delaware Corporation.

(ii) Related Appeals and Interferences

No related interferences or Appeals are currently pending.

(iii) Status of the Claims

Claims 1-22 have been presented in the application. Claim 1 was cancelled in an amendment filed July 2, 2007. Claims 2-22 are currently pending. Claims 2-22 are rejected. Claims 2, 4-20 and 22 are the subject of this appeal and are set forth in the Claims Appendix.

(iv) Status of Amendments

Claims 2-22 were finally rejected in an Office Action ("FA") mailed September 17, 2007. An Amendment After Final was filed on November 12, 2007, in which it was requested to cancel claims 3 and 21 and to amend claims 7, 8, 11, 12, 15 and 16. The amendment was refused entry in an Advisory Action mailed November 29, 2007. As a consequence claims 2-22 remain in the application in the form as they stood on the date of the Final Rejection.

In view of the applicant's stated willingness to cancel claims 3 and 21, the rejection of those claims is not being appealed. Consequently the appealed claims are claims 2, 4-20 and 22.

(v) Summary of Claimed Subject Matter

A summary of the independent claims, as required by 37 C.F.R. § 41.37(c)(1)(v), and a non-limiting listing of locations where support may be found {braced citations} is provided below.

Independent claim 17 recites: A method of forming a medical device comprising the steps of {Original claim 17; page 3, lines 1-2}

placing a parison in a mold having a cavity with a wall form substantially conforming to the desired shape of said device {Original claim 17; page 3, lines 3-4; page 6, lines 32-33},

immersing the mold in a heated liquid fluid to heat the parison {Original claim 17; page 3, line 5; page 3, line 32; page 4, lines 29-31; page 6 line 33-page 7 line 1; page 7, lines 6-10}, and

pressurizing the parison to radially expand the parison to contact the walls of the mold cavity {Original claim 17; page 3, lines 6-7; page 7, lines 1-2},

wherein the mold cavity wall contains at least one through-hole therein through which the heated liquid fluid enters the mold cavity to directly contact the parison when the mold is immersed in the heated fluid and through which heated liquid fluid that has entered the mold cavity is expelled therefrom when the parison is radially expanded {Original claim 17; page 3, lines 8-13 page 4, lines 23-27; page 7, lines 2-5, numeral 24 in Figs 1 and 2; numeral 32 in Figs 3 and 4}.

(vi) Grounds of Rejection to be Reviewed on Appeal

1. Whether the Examiner erred in objecting to the specification on the asserted grounds that the specification amendment filed July 2, 2007 introduced new matter in violation of 35 USC §135(a), and in rejecting claims 17 and 22 under 35 USC §112, first paragraph on the asserted basis that the claims do not meet the written description requirement?

2. Whether the Examiner erred in rejecting claims 2 and 4-16 under 35 USC §112, second paragraph on the asserted basis that the claims on the claims are indefinite for failing to "further define the methodical step-wise invention of independent claim 17"?

3. Whether the Examiner erred in rejecting claims 17, 20, 22, 2, 4-5, 7-9, and 13-14 under 35 USC §102 as anticipated by Leonhardt (US 5,522,961)?

4. Whether the Examiner erred in rejecting claims 6, 10-12, and 15-16 as obvious from Leonhardt (US 5,522,961)?

5. Whether the Examiner erred in rejecting claim 18 as obvious from Leonhardt (US 5,522,961) taken with Gass-Erb (US 3,766,358)?

6. Whether the Examiner erred in rejecting claim 19 as obvious from Leonhardt (US 5,522,961) taken with Garrett (US 6,073,540)?

(vii) Arguments

A. The Invention

The claimed invention is directed to a molding method for preparing medical devices, *e.g.* balloons, from parisons that are expanded within the mold by pressurization. The method uses a mold that is configured with holes that allow the liquid heating fluid to enter the mold. Essential to the process is that the holes are configured to allow the heating fluid to enter and contact the parison and then be expelled as the parison expands. The method provides the advantage of a more direct and so more consistent heating of the parison, which in turn improves balloon performance reliability and is particularly advantageous for large balloon sizes. See page 7, lines 24 - page 8, lines 4.

B. The Rejections

1. The Examiner Erred in Objecting to the Specification on the Asserted Grounds that the Specification Amendment Filed July 2, 2007 Introduced New Matter in Violation of 35 USC §135(a) and in Rejecting Claims 17 and 22 Under 35 USC §112, First Paragraph, on the Asserted Basis that the Claims do not Meet the Written Description Requirement.

1.1. The Disputed Amendment

The amendment filed July 2, 2007 amended the paragraph at page 3, lines 1-9 of the

application as follows:

> In another aspect the invention is directed to a method of forming a medical device comprising the steps of
> placing a parison in a mold having a cavity with a wall form substantially conforming to the desired shape of said device,
> immersing the mold in a heated liquid fluid to heat the parison, and
> pressurizing the parison to radially expand the parison to contact the walls of the mold cavity, wherein:
> the mold cavity wall contains at least one through-hole therein through which the heated liquid fluid enters the mold cavity to directly contact the parison when the mold is immersed in the heated fluid and through which heated liquid fluid that has entered the mold cavity is expelled therefrom when the parison is radially expanded.

The same amendment added the word to claim 17 and inserted claim 22 as a new claim:

> 17. (Currently Amended) A method of forming a medical device comprising the steps of
> placing a parison in a mold having a cavity with a wall form substantially conforming to the desired shape of said device,
> immersing the mold in a heated liquid fluid to heat the parison, and
> pressurizing the parison to radially expand the parison to contact the walls of the mold cavity, wherein the mold cavity wall contains at least one through-hole therein through which the heated liquid fluid enters the mold cavity to directly contact the parison when the mold is immersed in the heated fluid and through which heated liquid fluid that has entered the mold cavity is expelled therefrom when the parison is radially expanded.
>
> 22. (New) The method of claim 17 wherein the heated liquid fluid is water, glycerol or an oil.

In the Final Action the Examiner in making the new matter objection states:

> The added material which is not supported by the original disclosure is as follows: using a heated *liquid* fluid ...
>
> (FA, pg 2, Examiner's emphasis).

Similarly in making the written description rejection the Examiner states:

> There is no original support for applicant's amended claims which require a heated *liquid* fluid ...
>
> (FA, pg 2, Examiner's emphasis)

Therefore the question for decision by the Board is whether the word "liquid" is unsupported by the written description of the application as filed.

1.2 Applicable Law - New Matter/Written Description

The tests for new matter and sufficiency of written description support are the same, and are resolved together on appeal when specification objections and written description rejections are both present, as they are in the present case. MPEP 2163.06.

The legal issue presented is whether the disclosure "reasonably conveys to the artisan that the inventor had possession at that time of the later claimed subject matter." *Ralston Purina Company v. Far- Mar-Co., Inc.*, 227 USPQ 177 (Fed. Cir. 1985). In order to satisfy the written description requirement, the disclosure as originally filed does not have to provide *in haec verba* (identical language) support for the claimed subject matter at issue. *Fujikawa v. Wattanasin*, 93 F.3d 1559, 1570, 39 USPQ2d 1895, 1904 (Fed. Cir. 1996); *In re Wright*, 9 USPQ2d 1649, 1651 (Fed. Cir. 1989). The failure of the specification to specifically mention a limitation that later appears in the claims is not a fatal one when one skilled in the art would recognize upon reading the specification that the new language reflects what the specification shows has been invented. *All Dental Prodx LLC v. Advantage Dental Products Inc.*, 64 USPQ2d 1945, 1948 (CA FC 2002). Drawings alone have been found to provide the necessary written description for a claimed invention. *VasCath Inc. v. Mahurkar*, 19 USPQ2d 1111 (Fed. Cir. 1991).

MPEP 2163.07(a) states:

> By disclosing in a patent application a device that inherently performs a function or has a property, operates according to a theory or has an advantage, a patent application necessarily discloses that function, theory or advantage, even though it says nothing explicit concerning it. The application may later be amended to recite the function, theory or advantage without introducing prohibited new matter.

1.3 Argument

The application discloses heated water or oil as typical heating fluids at page 4, lines 29-32 and water, glycerol, mineral oil or silicone oil at page 7, lines 7-9, and a water temperature of 90°C to about 99°C is specifically mentioned. These are liquids. (To the extent necessary, the Board is requested to take official notice that the atmospheric pressure boiling point of water is 100°C, by definition.) Consequently the application clearly discloses fluids that have the inherent property of being liquids. That is all that is needed to support the addition of the word "liquid" in the specification and claims. MPEP 2163.07(a). Further the application discloses that "those with relatively lower viscosities are preferred," (page 7, line 10) which a skilled person will understand to be directed to relative properties of the liquid fluids. Still further the application contrasts the heating the parison by direct contact with the heating fluid with indirect transfer through the space between the mold cavity (page 7, lines 24 - page 8, line 4), a contrast that requires that the heating fluid be different from air.

The skilled person clearly understands from the original disclosure that the heated fluid employed in the inventive method may be a liquid. According to the controlling case law this is sufficient to satisfy the written description requirement. No new matter has been added and the written description is satisfied.

In the Advisory Action (continuation sheet) the Examiner states:

> Although the original specification discusses preferred embodiments of the heating fluid as having particular viscosities and lists several liquids as examples, it is not believed that this preferred embodiment renders the application exclusive to liquids For example, although viscosity is a property of liquid, it is also a property of gas.

This statement reveals a fundamental misunderstanding of the written description requirement as it applies to the present invention. There is no requirement that the skilled person have to believe that the fluids are "exclusive" to liquids. All that is needed to support the recitation is for the skilled person to be able to recognize that liquids are inherently encompassed by the heating fluid disclosure. The Examiner's acknowledgment that preferred embodiments are recognizably liquids is sufficient to support the claim and specification amendments. Amending the specification and claims to focus on preferred embodiments does not and has never raised a new matter/written description issue.

The new matter objection and written description rejection are clearly unwarranted. Reversal is respectfully requested.

2. The Examiner Erred in Rejecting Claims 2 and 3-16 under 35 USC §112, Second Paragraph on the Asserted Basis that the Claims are Indefinite for Failing to "Further Define the Methodical Step-wise Invention of Independent Claim 17."

2.1 The Rejection

The Final Office Action contends for claims 2-16 that "[i]t is unclear how the claims further define the methodical stepwise invention of independent claim 17." (FA, page 3). the

In the Advisory Action (continuation sheet) the Examiner states:

> The test for a proper dependent claim under the fourth paragraph of 35 USC §112 is whether the dependent claim includes every limitation of the claim from which it depends Although the claims 2-16 refer to various physical elements mentioned in independent claim 17, it is not seen how they include every limitation of the method of claim 17; their construction does not even refer to any method steps of claim 17. Therefore, it is unclear

how they further limit the method of claim 17.

As a consequence of this latter statement it is not clear whether the Examiner intends the rejection to be one for indefiniteness (35 USC §112, second paragraph) or for improper dependency 35 USC §112, fourth paragraph).

2.2 Applicable Law

The requirement of 35 USC §112, second paragraph, is that the meaning of the claim be discernable. See MPEP §2173.02. The test is whether "those skilled in the art would understand what is claimed when the claim is read in light of the specification." *Ortho kinetics, Inc. v. Safely Travel Chairs, Inc.*, 806 F.2d 1565, 1576, 1 USPQ2d 1081, 1088 (Fed. Cir. 1986).

The requirement of 35 USC §112, fourth paragraph, is that a dependent claim recite a further limitation of the subject matter claimed.

2.3 Argument

Claim 3 is not being appealed so the argument is directed to claims 3 and 4-16.

2.3.1 Claims 2, 4-6, 9-10 and 13-14

As discussed in part A above, Independent claim 17 recites a method that includes a mold form with through holes that allow and facilitate liquid heating fluid with the parison and so facilitate rapid heat transfer to the parison. The mold form configuration is therefore a fundamental feature of the claimed method. Claims 2 and 3-16 recite other configuration features of the mold form such as hole shape, hole patterning and hole size. All of these features further limit the scope of claim 17 by adding limitations to the definition of the mold form that is employed in the method. Any of claims 2, 4-6, 9-10 and 13-14 may be taken as representative.

The Examiner cites no authority for the proposition that the subject matter of a method claim is not further limited by recitations narrowing the types of apparatus used to practice the method. The proposition on its face is ridiculous.

The Examiner has not argued that the subject matter of the claims cannot be understood. Rather, the Examiner seems to be trying to create a wholly new basis for rejection of method claims. The contention that the dependent method claims are unclear if they do not add further "methodical stepwise" limitations is utterly unprecedented. Applicants are entitled to have their cases examined according to the law as it is, not according to what the Examiner might think it should be.

The rejection should be reversed as to claims 2, 4-6, 9-10 and 13-14.

2.3.2 Claims 7, 8, 11, 12, 15 and 16

The same arguments apply to claims 7, 8, 11, 12, 15 and 16. The claims are understandable in the context of the application and all add recitations further limiting the configuration of the mold form. These claims are being argued separately because, independent of the Examiner's stated grounds for rejection, the applicant has noted that these claims can be written to clarify the connection between the added recitation and the antecedent mold form structure. In the Amendment After Final filed November 12, 2007, the applicant attempted to resolve these issues by replacing the words "comprising" or "having" in the respective claims with "wherein the mold cavity has." The amendment was refused entry in the Advisory Action, apparently on the basis that the Examiner did not see that they resolved any outstanding issues. Accordingly it is submitted that the Board should rule only on the merits of the Examiner's ground for rejection. The rejection should be reversed as to claims 7, 8, 11, 12, 15 and 16.

To the extent that the Board may be inclined to impose new "antecedent basis" grounds for rejecting any of claims 7, 8, 11, 12, 15 and 16 under §112, second paragraph, it is respectfully submitted that the rejection would only be applicable to claims 2, 4-6, 9-10 and 13-14 and that the applicant should be given the opportunity to remove the rejection by resubmitting the amendments proposed in the Amendment After Final.

3. The Examiner Erred in Rejecting Claims 17, 20, 22, 2, 4-5, 7-9, and 13-14 under 35 USC §102 as Anticipated by Leonhardt (US 5,522,961)

3.1 The Rejection

Claims 17, 20, 22, 2-5, 7-9 and 13-14 have been rejected as anticipated by Leonhardt, US 5,522,961. A copy of Leonhardt is attached in the Evidence Appendix, item A.

3.2 Applicable Law

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California,* 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). *In re Marshall* , 578 F.2d 301, 304, 198 USPQ 344, 346 (CCPA 1978); *Ex parte Gould* 6 USPQ2d 1680 (BdPatApp&Int 1987). *See also,* MPEP 2131. The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Reliance on inherency in an anticipation analysis requires evidence that the missing descriptive matter is "necessarily present" in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. MPEP §2131.01 (III); *Continental Can Co. USA v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749 (Fed. Cir. 1991). ***Inherency may***

not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient. *Continental Can*, 948 F.2d at 1269, 20 USPQ2d at 1749; *In re Robertson*, 49 USPQ2d 1949, 1951 (Fed. Cir. 1999).

3.3 Argument

Independent Claim 17 recites that "the heated liquid fluid enters the mold cavity to directly contact the parison when the mold is immersed." This direct contact provides significant process advantages as discussed in section A, above. Claims 20, 22, 2-5, 7-9 and 13-14 depend from claim 17 and so also include this feature and its attendant advantages.

Leonhard pertains to a balloon molding process in which a mold is immersed into a bath of water, and the mold has holes 46. However Leonhard specifically teaches that the holes 46 "provide for the escape of ***air*** when the mold is filled by the expanding workpiece" (col. 3, lines 62-64) (emphasis added). Thus it is clear that the holes are not sized or channeled in a way that permits water to enter the cavity and contact the parison as recited in claim 17.

The Examiner contends that "water would pass through the holes 46 while the mold is submerged" in Leonhard's molding process, and that air and water will be expelled when the parison is expanded" (FA, page 6). This assertion is clearly incorrect. First, Leonhardt immerses for 30-35 seconds before pressurization (col. 4, lines 28-30) so, if the holes are of sufficient size to allow water in, there would be ***plenty of time*** for the mold to completely fill. Second, the bottom of the mold is on the right side of Fig. 2 (see col. 4, lines 12-14) so, if water does enter the mold, there is no location of the cavity in which air would be trapped. If it comes in at all, the mold cavity will ***completely fill*** with water. There will be no air left in the mold to be expelled when the parison expands. Third, the mold is ***transparent*** (col. 3, lines 52-53). Leonhardt clearly

can see if water enters the mold when it is immersed and if it is expelled when the parison expands. In that context the fact that Leonhardt teaches that the holes "provide for the escape of air when the mold is filled by the expanding workpiece" can only be reasonably taken as an explicit teaching that the holes ***do not*** permit entry of water when the mold is immersed.

Finally, the Examiner contends that attorney's arguments cannot take place of evidence in the record citing MPEP 2145(FA, Page 6). MPEP 2145 does not apply to anticipation rejections. Furthermore, in this case, Leonhard itself provides the evidence in the record. Applicant has no burden to show that Leonhard operates according to its express teaching. It is the Examiner that is contending that Leonhard operates in a manner different from what it expressly teaches, and it is that contention that has ***no evidentiary support*** in the record.

Reversal of the anticipation rejection on Leonhardt is therefore respectfully requested.

4. The Examiner Erred in Rejecting Claims 6, 10-12, and 15-16 as obvious from Leonhardt (US 5,522,961).

4.1 The Rejection

Claims 6, 10-12 and 15 -16 have been rejected for obviousness from Leonhardt. The Examiner contends that the recitations of these claims are obvious matters of design choice (FA Pages 4-5). As discussed above, these claims depend from claim 17 and recite further configuration features of the mold form.

4.2 Applicable Law

MPEP 2142 discussing the legal concept of *prima facie* obviousness articulates how the obviousness determination is to be made:

> To reach a proper determination under 35 U.S.C. 103, the examiner must step backward in time and into the shoes worn by the hypothetical "person of ordinary skill in the art" when the invention was unknown and just before it was made. In view of all factual information, the examiner must then make a determination whether the claimed invention "as a whole" would have been obvious at that time to that person. Knowledge of applicant's disclosure must be put aside in reaching this determination, yet kept in mind in order to determine the "differences," conduct the search and evaluate the "subject matter as a whole" of the invention. The tendency to resort to "hindsight" based upon applicant's disclosure is often difficult to avoid due to the very nature of the examination process. However, impermissible hindsight must be avoided and the legal conclusion must be reached on the basis of the facts gleaned from the prior art.

Rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006). See also *KSR International Co. v. Teleflex Inc.,* 550 U.S. ___, ___, 82 USPQ2d 1385, 1396 (2007).

4.3 Argument

The rejection suffers the same deficiency as the anticipation rejection of claim 17, see section 3.3 above. Leonhardt teaches holes that permit egress of air as the parison expands, an event that occurs 30-35 seconds after immersion of a transparent mold with holes at the top of the cavity. By this teaching the skilled person is explicitly led away from the present invention. Stepping back to Leonhardt alone, and removing applicant's disclosure from the mind (as required by MPEP 2142 and the Supreme Court *KSR* decision), removes any reason, suggestion or motivation to modify Leonhardt's mold holes to permit the water to enter and fill the mold cavity. The rejection should be reversed for at least this reason.

Further, with regard to claim 15 (which recites a plurality of through-holes "formed as slots having a minor dimension from about 0.1 mm to about 1.5 mm, and a major dimension of at

least about 0.2 mm") and claim 16 (which recites a plurality of through-holes "in the form of substantially circular holes having a diameter of from 0.1 mm to about 1.5 mm"), the size of the hole is not merely a matter of design choice. In the present invention the object is to get liquid heating fluid into contact the parison, and to provide egress for expulsion of the heating fluid when the parison is expanded. The specified sizes facilitate that function.

In Leonhard the holes don't allow the heating fluid to enter the mold cavity and their object is to let air out when the parison expands. These different design criteria between the holes in the claimed invention and the Leonhardt holes will be smaller, so as to prevent water penetration.

At least for the reasons given above reversal of the obviousness rejection of claims 6, 10-12 and 15 -16 on Leonhardt is requested.

5. The Examiner Erred in Rejecting Claim 18 as obvious from Leonhardt (US 5,522,961) taken with Gass-Erb (US 3,766,358).

5.1 The Rejection

Claims 18 and 21 have been rejected as obvious from Leonhardt in view of Gass-Erb. In the un-entered Amendment claim 21 was attempted to be cancelled. Consequently the rejection is traversed only as to claim 18. The rejection of claim 18 asserts that Leonhardt is relied upon for the aspects of claim 17 and that Gass-Erb shows that it is known to carry out a method comprising agitating a heated fluid while an object is immersed therein (FA, page 5). A copy of Leonhardt is attached in the Evidence Appendix, item A. A copy of Gass-Erb is attached in the Evidence Appendix, item B.

Claim 18 reads as follows:

18. A method as in claim 17, further comprising agitating the heated fluid while the mold is immersed therein.

5.2 Applicable Law

The law applicable to this rejection is as stated in section 4.2, above.

5.3 Argument

The rejection of claim 18 should be reversed for at least the reason that Leonhardt does not meet the recitations of claim 17 as set forth in section 3.3 above, and does not make obvious a modification of Leonhardt as set forth in section 4.3 above. Gass-Erb is not asserted to make obvious use of holes in the mold that are configured allow entry of heating fluid into Leonhardt's molds so the combination fails to meets all of the recitations of the claim.

Moreover, the applicant disagrees with the Examiner's characterization of Gass-Erb. In Gass-Erb the immersed object is a heater that also performs the agitation, not some additional object analogous to a balloon mold. Thus there is nothing in Gass-Erb that is analogous to the claimed mold. The immersed object is a heater that also performs the agitation, and nothing in that document indicates that agitation should be performed "while the mold is immersed." There is no mold and so coinciding the timing of agitation with mold immersion clearly is not taught or suggested.

The Final Office Action asserts that the document shows agitation with an immersed object. The applicants point is that the immersed object is the heater. It is not being heated by the fluid. The problems are not analogous.

Reversal of the rejection of claim 18 on Leonhardt in view of Gass-Erb is respectfully requested.

6. The Examiner Erred in Rejecting Claim 19 as obvious from Leonhardt (US 5,522,961) taken with Garrett (US 6,073,540).

6.1 The Rejection

Claim 19 has been rejected as obvious from Leonhardt in view of Garrett. The Examiner asserts that Garrett shows that it is known to carry out "a method including vibrating the article." (FA, page 6). A copy of Leonhardt is attached in the Evidence Appendix, item A. A copy of Garrett is attached in the Evidence Appendix, item C.

Claim 19 reads as follows:

> 19. A method as in claim 17 further comprising vibrating the molding apparatus while the mold is immersed in the heated fluid.

6.2 Applicable Law

The law applicable to this rejection is as stated in section 4.2, above.

6.3 Argument

The rejection suffers the same deficiency as the rejection of claim 17 and is traversed for at least that reason. Leonhardt does not meet the recitations of claim 17 as set forth in section 3.3 above, and does not make obvious a modification of Leonhardt as set forth in section 4.3 above. Nothing in Garrett is asserted to make obvious use of holes in the mold that are configured allow entry of heating fluid into Leonhardt's molds so the combination fails to meets all of the recitations of the claim. Reversal of the rejection is therefore requested

Moreover, Garrett is clearly non-analogous art. Garrett pertains to a method of heating food containers submerged or partially submerged and running on a conveyer belt. A vibrator unit vibrates the pool of heat transfer liquid, the conveyer and the containers.

The skilled person molding a medical device balloon would not look to a device such as disclosed in Garrett for guidance in modifying a balloon molding process. Stepping back from thee applicant's disclosure, and asking the relevant question would someone reading Leonhardt look to Garrett for ideas on how to modify the apparatus, answers itself. It would never happen. The process, apparatus and articles of Garrett are too different to be of any interest to the person of skill in the balloon blowing art. At least for this additional reason reversal of the obviousness rejection of claim 19 on Leonhardt in view of Garrett is respectfully requested.

C. Conclusion

For at least the reasons presented above, reversal of the outstanding rejections as applied to claims 2, 4-20 and 22 is respectfully requested.

Respectfully submitted,
VIDAS, ARRETT & STEINKRAUS

Date: April 10, 2008

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(viii) Claims Appendix

2. The method of claim 17 wherein the through-hole is formed as a slot.

4. The method of claim 3 wherein the through-holes are formed as longitudinally oriented slots.

5. The method of claim 4 wherein the slots are arranged in a plurality of circumferentially spaced columns.

6. The method of claim 5 wherein the slots of circumferentially alternating columns of slots are staggered longitudinally.

7. The method of claim 5 comprising at least three of said circumferentially spaced columns of slots.

8. The method of claim 7 comprising four of said circumferentially spaced columns of slots.

9. The method of claim 17 wherein the at least one through-hole has a dimension at the mold cavity wall inner surface which does not allow substantial penetration of the parison material therethrough when heated to the temperature of the heated fluid and pressurized at a pressure sufficient to expand the parison to contact the mold cavity wall.

10. The method of claim 17 wherein the at least one through-hole has a circular, diamond or square shape at the cavity wall inner surface.

11. The method of claim 17 having a plurality of said through-holes arranged according to a pattern which extends circumferentially around the cavity wall.

12. The method of claim 17 having a plurality of said through-holes arranged according to a

pattern which extends helically around the cavity wall.

13. The method of claim 17 wherein the cavity has a portion having a diameter of at least 5 mm.

14. The method of claim 13 wherein said diameter is from about 8 mm to about 50 mm.

15. The method of claim 13 having a plurality of said through-holes formed as slots having a minor dimension from about 0.1 mm to about 1.5 mm, and a major dimension of at least about 0.2 mm.

16. The method of claim 13 having a plurality of said through-holes in the form of substantially circular holes having a diameter of from 0.1 mm to about 1.5 mm.

17. A method of forming a medical device comprising the steps of

placing a parison in a mold having a cavity with a wall form substantially conforming to the desired shape of said device,

immersing the mold in a heated liquid fluid to heat the parison, and

pressurizing the parison to radially expand the parison to contact the walls of the mold cavity, wherein the mold cavity wall contains at least one through-hole therein through which the heated liquid fluid enters the mold cavity to directly contact the parison when the mold is immersed in the heated fluid and through which heated liquid fluid that has entered the mold cavity is expelled therefrom when the parison is radially expanded.

18. A method as in claim 17, further comprising agitating the heated fluid while the mold is immersed therein.

19. A method as in claim 17 further comprising vibrating the molding apparatus while the mold is immersed in the heated fluid.

20. A method as in claim 17 wherein the mold cavity wall contains a plurality of said through-holes therein.

22. The method of claim 17 wherein the heated liquid fluid is water, glycerol or an oil.

(ix) Evidence Appendix

A. Leonhardt, US 5,522,961

B. Gass-Erb, US 3,766,358

C. Garrett, US 6,073,540

Appeal Brief - Evidence Appendix A

Leonhardt, US 5,522,961

US005522961A

United States Patent [19]

[11] **Patent Number: 5,522,961**

[45] **Date of Patent: Jun. 4, 1996**

Leonhardt

[54] **METHOD OF CONSTRUCTION OF A BALLOON CATHETER**

[75] Inventor: **Howard J. Leonhardt**, Davie, Fla.

[73] Assignee: **World Medical Corporation**, Sunrise, Fla.

[21] Appl. No.: **325,605**

[22] Filed: **Oct. 19, 1994**

Related U.S. Application Data

[62] Division of Ser. No. 979,248, Nov. 11, 1992, Pat. No. 5,370,618.

[51] **Int. Cl.**^{6} **B29C 49/00**; B29C 65/02; C09J 5/02

[52] **U.S. Cl.** **156/252**; 156/280; 156/292; 156/294; 156/308.6; 264/523; 264/526

[58] **Field of Search** 156/196, 252, 156/292, 294, 244.13, 244.14, 245, 308.6, 280; 264/523, 532, 573, 526; 604/96, 100, 103, 271; 606/192, 194

[56] **References Cited**

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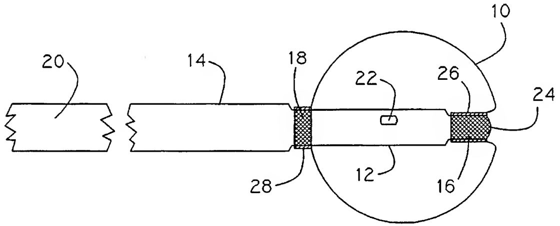
Primary Examiner—Steven D. Maki
Attorney, Agent, or Firm—John M. Brandt

[57] **ABSTRACT**

The method of manufacturing a polyurethane balloon catheter from a length of tubing of such material wherein the tubing is placed in a mold of the desired final expanded shape, the mold and tubing are immersed in a bath of warm water, and air pressure is introduced into the tubing to effect the expansion and then withdrawn to allow the removal of the balloon.

6 Claims, 1 Drawing Sheet



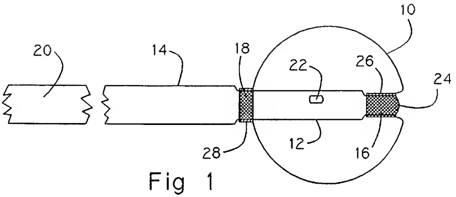


Fig 1

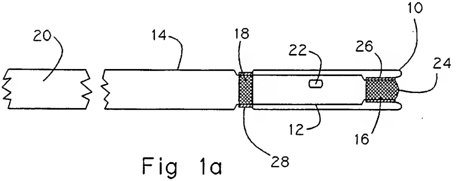


Fig 1a

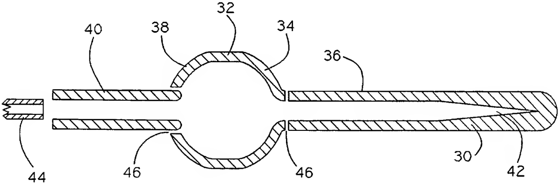


Fig 2

METHOD OF CONSTRUCTION OF A BALLOON CATHETER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional application of Ser. No. 07/979,248 filed Nov. 11, 1992 now U.S. Pat. No. 5,370,618.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention resides in the field of pulmonary artery balloon catheters and more particularly relates to low inflation pressure, low deflated profile, self centering polyurethane devices.

2. Description of the Prior Art

Pulmonary artery balloon catheters for measuring pressures within the vascular system are well known devices in the medical field. Their primary purpose is, after insertion into the body of the patient, to provide a means for performing such measurements by inflating the balloon attached to the catheter tip. This is accomplished, for example, by the introduction of fluid into the balloon through the catheter by a syringe located externally to the patient. These catheters are intended to be left within the body for an extended period of time and therefore their construction as well as their maneuverability, manipulation, and activation with minimum danger to the patient are of great concern.

The primary material for manufacturing these balloons heretofore has been latex. There are a number of drawbacks to the use of latex which are alleviated entirely or in part by the employment of polyurethane in accordance with applicants invention. Among these drawbacks are the following.

Inflation of latex balloons is erratic due to the high tension of the material compared to polyurethane. This results in a surge to full size when the critical inflation pressure is reached as well as a tendency to inflate non uniformly or out of round nearest the catheter inflation port.

As a natural material, latex varies from lot to lot, decomposes or spoils easily and is difficult to extrude with even wall thickness.

Mechanically, it is not as durable as polyurethane, fragments when it bursts, diffuses filling gases quickly and absorbs bodily fluids. Further latex has a rougher surface making balloons composed of that material more difficult to introduce into the body and more likely to promote blood clots upon long periods of in-dwell.

Additionally latex has undesirable toxins and pollutants from its source and processing and can cause severe allergic reactions in some patients.

Finally it is not as easily mounted on a catheter requiring adhesives and metal bands which may be avoided with polyurethane by using solvents.

The use of polyurethane as a catheter balloon material has however been disclosed in the prior art. For example U.S. Pat. No. 4,913,701 Tower, describes a polyethylene catheter employing a thermoset polyurethane balloon attached by cuffs and an appropriate adhesive. The references contained therein particularly U.S. Pat. No. 4,661,095, Taller et al. further disclose various aspects of the technology involved in this endeavor.

Applicant has now discovered that by constructing such catheters and balloons of a particular material in a particular way, a superior device can be created which overcomes

many of the deficiencies of those comprised of latex and those comprised of polyurethane as has been previously disclosed.

SUMMARY OF THE INVENTION

The invention may be summarized as a low deflated profile, low inflation pressure, self centering polyurethane balloon catheter. The balloon is comprised of substantially 80A durometer 0.004 inch wall thickness material and is preferably formed by blow molding in a bell shaped mold to achieve a device of particular elasticity which behaves upon inflation and deflation in a specific and desirable manner.

In contrast to the prior art, the catheter balloon of the invention obtained by the unique method of manufacturing disclosed herein provides a number of features and advantages constituting a significant advance in the field of pulmonary artery pressure measurements. For example the design and method of construction of the balloon provides a catheter which self centers in the artery under blood flow upon inflation. This results from an initial low inflation pressure characteristic which fills the balloon uniformly to an unstretched state followed by an additional application of inflation pressure which expands and stretches the balloon to the desired diameter and shape. Additionally the design and method of construction produce a rapidly obtained low deflated profile upon the release of inflation pressure without the necessity of drawing a vacuum, a result of the inherent elastic memory of the device. Further, by the use of a solvent to smoothly join the catheter and balloon rather than the mechanical or adhesive bonds of previous devices, the opportunity for blood clotting is greatly reduced. This is a particularly desirable aspect of the invention as these types of catheters normally dwell within the patient for a number of days.

Additional features which enhance the effectiveness and reliability of the invention include the use of epoxy for balloon-catheter joint reinforcement, and the arrangement of the balloon to cover the catheter tip when deflated.

The balloon is preferably made by introducing extruded 70A to 95A durometer polyurethane tubing into a clear acrylic or glass mold with a bell shaped cavity. The mold is dipped into hot water, and stabilized at about 165 degrees F. for about 35 seconds. One end of the tubing which is in the mold is plugged. The other end of the tubing which is outside of the mold is attached to a syringe. When the mold has been in the hot water for the required time, pressure is exerted into the tubing by advancing the plunger of the syringe filled with air. The tubing expands due to the air pressure to fill the shape of the cavity. The action of the tubing expanding to fill the cavity can be visually seen through the clear walls of the mold. When formation of the balloon is finished, the clear balloon material most often turns white for a second and then back to clear.

The mold is pulled from the hot water and dipped into cold water preferably within about two seconds of witnessing the extruded material filling the cavity. The plunger of the syringe is withdrawn collapsing the balloon allowing removal from the mold. Excess tubing material is trimmed and the proximal end of the balloon attached to the catheter by an appropriate solvent. The distal end is then everted over or reversed onto the catheter shaft below the proximal end and again attached with solvent complete the integration of the balloon and catheter. Everting provides a means for the balloon to cover the catheter tip on deflation. It is not necessary to obtain the other characteristics of the invention.

The above described features and advantages of the invention will be more clearly understood from the description of the preferred embodiment and the accompanying drawings which follow.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross sectional view of the balloon in the inflated state which comprises the preferred embodiment of the invention;

FIG. **1***a* is a cross sectional view of the balloon of FIG. **1** in the deflated state; and

FIG. **2** is a cross sectional view of a mold used to construct the preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, there is illustrated a catheter balloon in the inflated state comprising the preferred embodiment of the invention. Balloon **10** comprised of 70A to 95A durometer polyurethane of 0.004 inch wall thickness is disposed in neck section **12** formed at the distal end of polyurethane catheter **14**. It is attached so as to be fluid tight at sections **16** and **18** and is preferably secured by the application of a solvent, cyclohexanone for example. Inflation and deflation is accomplished by the introduction or withdrawal of fluid at the proximal end **20** of catheter **14** connecting with port **22** in the catheter wall. As shown in FIG. **1**, balloon **10** extends at its greatest inflated distal extremity beyond neck section **12**. Pressure is measured through the catheter by way of tip port **24** which is separated from the balloon inflation channels by a multi lumen interior structure not shown but as is well known to those skilled in the art. Catheter—balloon interfaces **16** and **18** may further be reinforced by the application of rings of epoxy **26** and **28** which serves to streamline the surface reducing the risk of blood clots and facilitating the introduction and removal of the entire device into the cardiovascular system of the patient. For the same purpose, the balloon is also mounted in a manner to provide for the tip of the catheter to be covered upon deflation as shown in FIG. 1*a*.

The specified elasticity (durometer) and wall thickness of the polyurethane directly result in the features and advantages of the invention described above. Although the balloon may be constructed in various ways a preferred method of construction as will be described below utilizing a mold has been found to yield a superior and reproducable device.

Referring to FIG. **2**, there is shown a cross sectional view of a mold particularly suited for the manufacture of the invention. Mold **30** is preferably composed of a clear material such a glass or acrylic.

It is cylindrical having a central portion **32** of greater diameter than each end portion and as shown such portion may be described as bell shaped, that is, the cross sectional slope **34** of the forward part **36** is less steep than cross sectional slope **38** of the rearward portion **40**.

Forward part **36** provides an end seal **42** and for that purpose is internally tapered to produce a wedge fit upon the insertion of a polyurethane tubing work piece **44**. Holes **46** provide for the escape of air when the mold is filled by the expanding workpiece.

A preferred method of construction of the balloon and catheter comprising the invention using the above described mold is as follows:

Extruded 80A durometer semi-elastic polyether, segmented, thermoplastic polyurethane tubing with a wall thickness of about 0.004" and an inside diameter appropriate to fit tightly over a catheter shaft is inserted into a glass mold with a bell shaped bulb in the center as is described above and is 15 percent smaller in diameter than the intended final inflated balloon size i.e. 10–13 mm. The bell shape of the mold is advantageous to reduce the amount of excess balloon material to provide the lowest deflated profile. The upper half of the mold is cylindrical in shape with a hole in the center with an inner diameter just large enough to freely accept the introduction of the polyurethane tubing. The bottom half of the mold is tapered so that the polyurethane tubing may be friction fitted and sealed at the bottom portion of the mold which is closed at the end. The polyurethane tubing is attached to a rigid tube with a diameter 20 percent larger than the polyurethane tubing by stretching the tubing over the rigid tube and melting or solvent bonding the polyurethane tubing to the rigid tube so that a seal is formed. The other side of the rigid tube has a luer lock connector so that a syringe with a pressure gauge may be attached. The syringe should have a volume at least equal to that of the intended end balloon inflation volume. After the syringe is attached to the rigid tube and the polyurethane tubing to the glass bulb mold and a seal is verified, the bell shaped glass bulb is immersed in a temperature controlled water bath of about 160 degrees F. to 168 degrees F. The mold is immersed just past the bulb in the mold. The bulb is left in the hot water for about 30 to 35 seconds, after which the syringe plunger is gradually advanced to expand the tubing. While pressure is increased with the syringe the tubing is constantly pulled back in a gentle manner. This removes slack from the tubing which when the tubing blows to fill the mold, would be pulled into the bulb and otherwise cause a mis-formed balloon. During about the last 10 percent of the depression of the syringe the polyurethane tubing will expand to fill the shape of the glass bulb. After the tubing is blown into the shape of the bulb more pressure is exerted to completely fill the corners of the mold and set the balloon shape. The mold is removed from the hot water bath and set in a cold water bath of about 40 degrees F. while the balloon is still inflated. After about 5 seconds, the syringe plunger is withdrawn to pull the tubing off the walls of the bulb and to pull the rigid tube away from the mold to remove the polyurethane tubing including the blown balloon bulb center from the mold. The bottom portion of the polyurethane tubing is pinched with a hemostat for example to seal the end and to allow inflation of the balloon in the air to test for symmetry and shape.

Unexpanded portions of tubing above and below balloon are cut, allowing a 2 mm section on each end for mounting purposes. The polyurethane material catheter is prepared by tapering the tip in two parts using a heated mold. The first taper, just long enough to accomodate the portion of the tubing to be bonded to the catheter, about 2 mm, is greater than the second longer taper, about 7 mm. The bottom portion of the balloon is then mounted on the top taper of the catheter by stretching the tubing of the balloon into place over the extra tapered 2 mm segment. When in place the solvent cylcohexanone is wiped onto the 2 mm segment using an ordinary nylon paint brush, avoiding contact with the blown balloon itself. A pair of heated crimping pliers may be used to crimp seal the 2 mm segment onto the catheter in addition to the chemical bonding. The balloon-catheter is then set aside for about 10 minutes to allow the chemical bond reaction created by the cylcohexanone. After this, the balloon is flipped over itself or everted creating a cone over the catheter tip and setting in place the second 2

mm segment of balloon tubing to be mounted onto the bottom portion of the polyurethane catheter tip tapered portion. This segment is bonded as the first by painting cyclohexanone on the segment to create a chemical bond between the polyurethane balloon tubing segment and the polyurethane catheter tapered portion. Again, a pair of heated crimping pliers may be used to reinforce the strength of the bond by melting the balloon tubing segment into the polyurethane catheter material. After allowing this segment to set for 10 minutes, epoxy bands are painted for example Isoproplidenediphenol epichlorohyrin based epoxy and/or similar isomers around the sections of the balloon tubing that were chemically bonded to the catheter. This serves the purpose of smoothing out the transition of the balloon to the catheter to reduce the chance of causing a stagnation point in the flow of blood. It also serves a second purpose of reinforcing the balloon to catheter bond and smoothing out the tip portion of the catheter to avoid scraping the inside of the blood vessel walls.

What is claimed is:

1. The method of manufacturing a balloon catheter comprising the steps of

(a.) providing a cylindrical mold having a central portion of greater diameter than each end portion;

(b.) providing a length of substantially 80A durometer polyurethane tubing having a wall thickness of substantially 0.004 inches;

(c.) inserting said tubing into said mold;

(d.) closing one end of said tubing;

(e.) immersing said mold and said tubing in a bath of warm water of a selected temperature for a selected time;

(f.) introducing pressurized air into said tubing to expand said tubing into said mold to create a balloon;

(g.) immersing said mold and said tubing in a bath of cold water of a selected temperature for a selected time;

(h.) withdrawing said air pressure to produce a vacuum to collapse said balloon;

(i.) withdrawing said balloon from said mold;

(j.) providing a catheter comprising a length of polyurethane tubing;

(k.) producing a fluid port in the wall of said catheter at one end;

(l.) placing one end of said balloon above said port and bonding said end with a solvent to said catheter to form a bonded juncture and everting the opposite end of said balloon over said end and bonding said opposite end to said catheter below said port to form another bonded juncture and thereby enclose said port; and

(m.) disposing a ring of epoxy on each of the bonded junctures of said balloon and said catheter.

2. The method of claim **1** wherein said solvent comprises cylcohexanone.

3. The method of claim **1** wherein said pressurized air is introduced into said tubing by the use of a syringe.

4. The method of claim **1** wherein said central portion of said mold is bell shaped.

5. The method of claim **1** wherein said selected temperature in step (e.) is about 160 to 168 degrees F. and said selected time in step (e.) is about 30 to 35 seconds.

6. The method of claim **1** further including the step of heat sealing said catheter and said balloon at the bonded junctures of said balloon and said catheter.

* * * * *

Appeal Brief - Evidence Appendix B

Gass-Erb, US 3,766,358

United States Patent [19]
Gass-Erb
[11] 3,766,358
[45] Oct. 16, 1973

[54] IMMERSION HEATER

[76] Inventor: Kurt Gass-Erb, Auf Schloss, Magden, Switzerland

[22] Filed: Apr. 27, 1972
[21] Appl. No.: 248,000

[30] Foreign Application Priority Data
April 28, 1971 Austria........................ A 3680/71

[52] U.S. Cl.................. 219/322, 219/328, 219/331, 219/335, 219/481, 219/501, 219/538
[51] Int. Cl.. F24h 1/06
[58] Field of Search...........219/280-281, 316-317, 219/322, 328, 330-331, 335, 338, 481, 538

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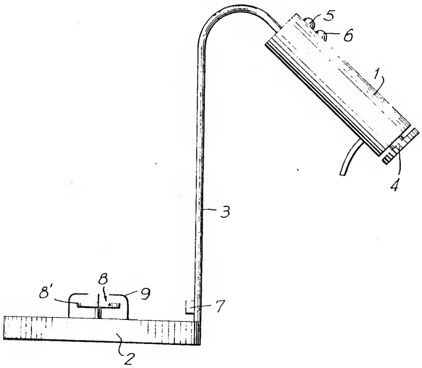
Primary Examiner—C. L. Albritton
Attorney—Eric H. Waters et al.

[57] ABSTRACT

An immersion heater including a heating element immersible in a fluid for heating the latter, and a mixing device for agitating the fluid mounted on the heating element. The mixing device is reciprocable in response to energization of an electromagnetic drive, and may be connected into the electrical circuit for the heating element so as to be operable in conjunction with the operation of the heating element or responsive to temperature levels sensed in the heating element.

25 Claims, 12 Drawing Figures



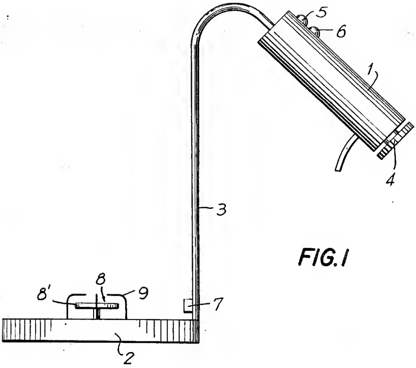
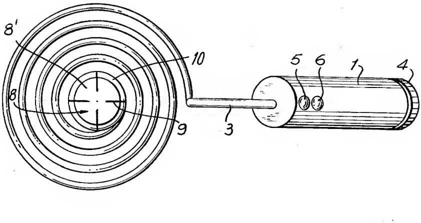


FIG. 1

FIG. 2



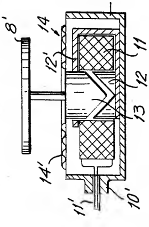


FIG.3

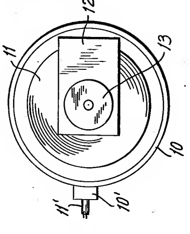


FIG.4

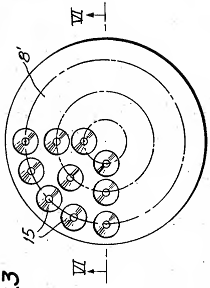


FIG.5

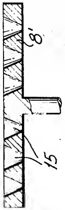


FIG.6

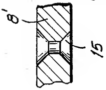


FIG.7

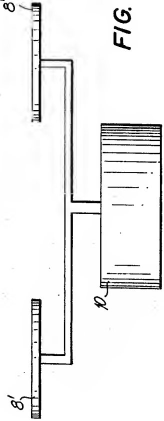


FIG.8

FIG. 9

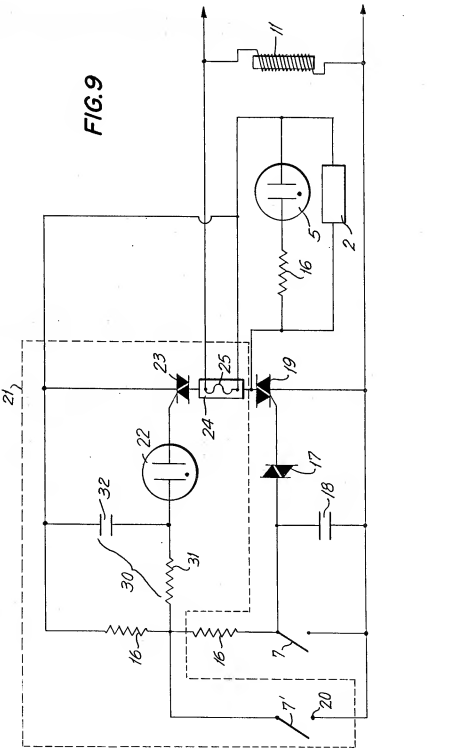
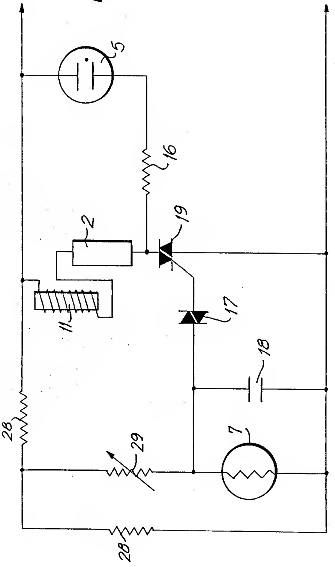


FIG.10



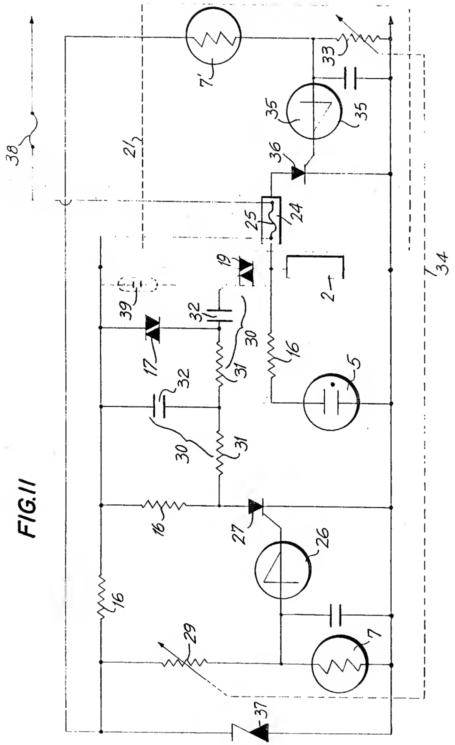


FIG.11

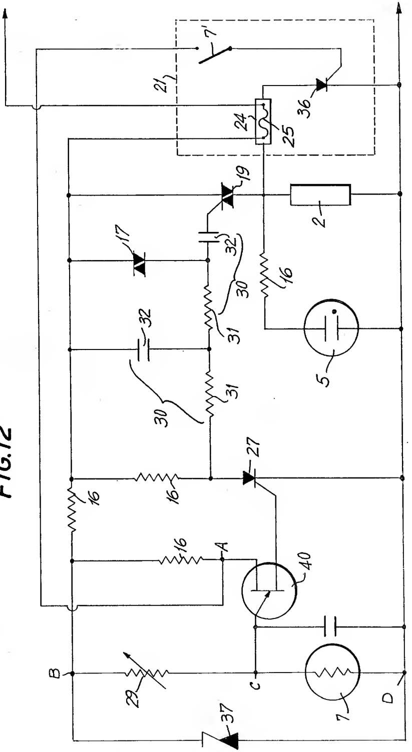


FIG.12

IMMERSION HEATER

BACKGROUND OF INVENTION

1. Field of the Invention

This invention relates to an immersion heater and, more particularly, to a heater having an automatic temperature control in which further heating is interrupted upon the heater reaching a predetermined maximum temperature.

2. Description of Prior Art

Heretofore, known immersion heaters of the above type have had the disadvantage in providing an unequal temperature distribution throughout the fluid being heated. In particular, when the heating element of the immersion heater fails to reach the lowermost layers of the fluid, the further generation of heat is frequently interrupted before these lowermost fluid layers can attain their required operating temperatures.

Furthermore, in prior art immersion heaters incorporating contact thermometers, if the contact thermometer fails to reach the heating spiral, the danger of overheating is created in which temperature deviations of up to 20° C may be encountered. In particular, in the chemical industry such temperature fluctuations are generally undesirable and not permissible since reactions of an unpredictable nature may be encountered, or in the carrying out of fractional distillations, clean separation of the elements of the mixture cannot be obtained.

Heretofore, in order to eliminate the shortcomings of prior art immersion heaters, agitation of the fluid being heated has been effected manually or through a separate stirring device. In the last instance, the related costs are relatively high, and furthermore, special supports are required for mounting the stirring devices in the vessel, making these inapplicable for rapid changes of the installation from one vessel to another. In particular, when applied to distillation plants, the limitations of space-consuming stirring devices become quite evident, since the vessels containing the fluid baths must be made relatively large in order to afford sufficient space for the stirring device. However, larger fluid baths require correspondingly greater energy supplies, thereby adversely affecting the economic operation of the plants. Additionally, such prior art plants or installations are relatively complex, and require a considerable amount of time for mounting and preparation.

SUMMARY OF THE INVENTION

Accordingly, the present invention contemplates the provision of an immersion heater which, in addition to incorporating advantageous and versatile temperature controls also provides for an optimum and equal temperature distribution throughout the fluid. In addition to the foregoing, the inventive immersion heater operates automatically and, furthermore, does not require servicing during operation.

The foregoing object of the present immersion heater is attained by providing, within the ambit of the electrical control current circuit of its heating element, a mixing device for the heated fluid.

Additionally, the immersion heater according to the present invention is formed of a compact constructure and operates essentially uninterruptedly. Another feature of the immersion heater lies in that the mixing device is rigidly fastened to the upper surface of the heating element and preferably is encompassed by a protec-

tive arrangement which permits unhindered flow of the fluid therethrough.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the invention may be readily ascertained from the following description of exemplary embodiments taken in conjunction with the accompanying drawings, wherein:

FIG. 1 illustrates an elevational view of an immersion heater according to the present invention;

FIG. 2 shows a plan view of the immersion heater of FIG. 1;

FIG. 3 shows a sectional view through a drive for a mixing device utilized with a heater according to the present invention;

FIG. 4 shows a plan view of the drive of FIG. 3;

FIG. 5 shows an enlarged detailed plan view of a portion of FIG. 3;

FIG. 6 illustrates a sectional view along line 6—6 in FIG. 5;

FIG. 7 shows an enlarged fragmentary sectional view of another embodiment of the arrangement of FIG. 3;

FIG. 8 illustrates a schematic view of a further embodiment of a mixing device used with a heater according to the present invention; and

FIGS. 9 – 12 illustrate four embodiments of wiring diagrams for an immersion heater according to the present invention.

DETAILED DESCRIPTION

Referring now in detail to the drawings, FIG. 1 illustrates a basic embodiment of the inventive immersion heater wherein a handgrip 1 is connected to a heating element 2 by means of a hollow rod 3 which is bent to provide a suspension arrangement for immersion of the heating element into fluid contained within a vessel. The hollow rod 3 concurrently provides a passageway for the electrical power conduit for heating element 2. Suitable elements constituting the temperature control installation are positioned in handgrip 1, the former of which may be formed of a contactless switch. This will effectively eliminate the risk of any sparks igniting flammable fluids or vapors emanating therefrom.

The contactless switch incorporates its own electrical control current circuit and a safety switching circuit, which will be described in greater detail herebelow with reference to the circuit diagrams.

A rotatable control knob 4 for an adjustable control resistance, a control lamp 5 for the control current circuit, and a control lamp 6 and 22 for a safety switching circuit 21, are each located on the handgrip. Each position of the rotatable knob 4 corresponds to a predetermined desired maximum operating temperature for heating element 2. Upon the operating temperature being attained, the flow of electrical current to heating element 2 is interrupted by means of a temperature sensor 7 which may be, for example, a thermistor. In the event that, through some operative defect, the heating cycle is not terminated, the safety switching circuit is actuated to thereby prevent excessive overheating of the fluid. A mixing device 8 is fastened to the upper surface of heating element 2, and is protected by a protective arrangement 9 so as to provide protection against damage not only during operation of the immersed heater, but also during storage and handling.

The protective arrangement 9 may be, as is shown in the drawings, constructed of four bent wires which ex-

tend over the mixing device. However, numerous other constructions readily lend themselves to the formation of the protective arrangement. Thus, for example, a housing of a wide-mesh grillwork may be stapled over the mixing device. In each instance it must, however, be noted that unhindered access of the fluid to the mixing device **8** must be provided by the protective arrangement.

As illustrated in FIG. **2**, the heating element **2** is formed as a heating spiral having the mixing device **8** centrally positioned thereon.

The drive or actuator and detailed construction of the mixing device **8** is illustrated in FIG. **3** of the drawing. As an agitator for the fluid, a preferably circular plate **8'** may be utilized which is reciprocable in an axial direction. This construction eliminates the need for the commonly used rotating elements in mixing devices, which must be constantly serviced and which are subject to a high degree of wear.

The drive or actuator for plate **8'** operates pursuant to electromagnetic principles and is sealed within a housing **10.** The main element of the drive consists of an induction coil **11** which is provided with electrical current through an electrical conduit **11'**. Accordingly, the coil **11** may be connected, for example, in series with the heating coils, and with the electrical control current circuit of the immersion heater. In this instance, upon a maximum predetermined temperature being attained, the mixing sequence is terminated concurrently with the flow of electric current to the heat coils of the heating element.

It is also possible to directly connect the induction coil **11** into the electrical circuit of the immersion heater to thereby provide a mixing device which, independently of the predetermined maximum operating temperature, is deactivated only upon the shutting-off of the immersion heater.

It is noted that in the first instance the winding of the induction coil **11** must be made in conformance with the current intensity required by the heating coils of the immersion heater, and is thereby formed of heavy copper wire, whereas in the second instance, the winding is formed pursuant to the supply voltage and is constituted of thin copper wire having a corresponding larger number of windings.

A stationary iron core **12** is located within housing **10**, and is fastened to induction coil **11**; with coil **12** having a portion **12'** extending over coil **11**, as shown in FIG. **4**, so as to provide a guide for a movable iron core **13** which is rigidly connected to plate **8'**. Plate **8'** is connected wtih a return motion element **14**. The latter may take the form of a membrane **14'** constituted of corrugated sheet metal, which concurrently forms the cover for housing **10.** Preferably, the movable iron core **13** is fastened to the inner wall surface of membrane **14'** and serves concurrently as support member for the plate **8'**. The electrical conduits **11'** extend into housing **10** through connecting sleeve **10'** and are sealed in the housing so as to permit the latter to protect the drive for the mixing device from corrosion and dirt.

The basic mixing device, in effect, plate **8'**, is provided with nozzles **15** extending in the direction of its reciprocating movement and parallel to the axis thereof, the nozzles being spaced about the entire surface of plate **8'**.

As shown in FIG. **5**, the nozzles **15** in plate **8'** may have the form of concentric, ring-shaped rows of apertures, or may be formed as axially widening tapered bores in FIG. **6**, or centrally narrowed bores as shown in FIG. **7.** In the construction according to FIG. **6**, the nozzles **15** may have their enlarged openings either upwardly or downwardly directed.

The operation of the mixing device is as follows:

Upon conduction of an alternating current through the copper windings of induction coil **11**, the movable iron core **13** is axially displaced in the direction of stationary iron core **12.** In response to movement of iron core **13**, the membrane **14'** and plate **8'**, which are rigidly fastened thereto, are correspondingly axially displaced.

Upon the alternating current moving through its "zero point," the membrane **14'**, and concurrently plate **8'** and iron core **13**, are snapped-back into the initial position thereof. This process is repeated in correspondence with the frequency of the current, for example at 50 Hertz, 50 times each second. Through this movement, in addition to the agitation of the fluid, a secondary advantageous mixing or agitating effect is provided through the nozzles **15** of plate **8'**. In this instance, in view of the funnel-shaped nozzles **15** the fluid is always recaptured and forced through the nozzles.

In order to further improve the mixing of the fluid, in accordance with the embodiment of FIG. **8**, two or more mixing plates **8'** may be combined for actuation by a single drive.

A simple switching circuit for the inventive immersion heater is disclosed in FIG. **9** of the drawing. The current flows through resistances **16**, which also form current limiters, toward trigger diode **17**. The trigger diode, with the aid of condensators **18**, switches through and concurrently ignites alternating current thyristor **19.** In response to the energy supply, the heating element **2** is heated and also, through the fluid, contact thermometers **7** and **7'** which serve as temperature sensors. The thermometer **7'** is located in a safety switching circuit **21** shown in chain-dotted lines in the circuit diagram. The actuating temperature of the safety switching circuit is somewhat higher than that of the thermometer **7** of the control current circuit. When the preset operating temperature is sensed by thermometer **7**, current flow through trigger diode **17** is terminated. Responsively, thyristor **19** prevents the flow of current through the heating element, thereby interrupting the further generation of heat, and concurrently turns off control lamp **5**.

In the event of a defect occuring, for example a break in thermometer **7**, which would prevent the shutting-off the heat upon reaching the required maximum operating temperature, the temperature at first rises to the temperature designated at contact thermometer **7'**. Upon this temperature being attained, contact **20** closes and the current thereby becomes insufficient to switch trigger diode **17**, thusly interrupting the heating sequence. Concurrently, upon contact **20** being closed by contact thermometer **7'**, the safety switching circuit **21** is actuated. The glow tube **22**, which serves a function which is similar to a trigger diode, and is furthermore also utilized as a control lamp **6**, triggers thyristor **23.** Since the current supply to trigger diode **17** and to alternating current thyristor **19** has been simultaneously interrupted, no current can flow across resistance **24**.

An excessive voltage in the circuit of alternating current thyristor 19 may damage the latter so as to prevent the closing thereof. Consequently, the temperature will then further rise until the preset temperature at contact thermometer 7' is reached. At that instance, as previously mentioned, thyristor 23 is triggered by glow tube 22. The resistance 24 warms itself, and wire 25 as a segment of the current supply conduit which extends across resistance 24, thereby melting the wire at a predetermined maximum temperature to thereby terminate the current supply. Similarly, wire 25 is adapted to melt upon experiencing an excessive ambient temperature. The melting wire 25 should be formed of an alloy having a low melting point, and may be commercially obtained for different heater temperature requirements. The wire may be readily introduced through a suitable aperture in resistance 24.

In this circuit arrangement, the induction coil 11 is directly connected to the electrical circuit for the mixing device. As previously mentioned, this requires numerous windings formed of thin wire and is operative independently of the operating temperature for the heater.

Another advantageous circuit is disclosed in FIG. 10, illustrating essentially only the control current circuit. Concurrently, this also shows that the induction coil 11 may be connected to the control current circuit 21 of the induction heater, and particularly in series with the electrical winding of heating element 2. In that case the coil 11 is designed in accordance with the required current intensities for the immersion heater, and is composed of a lesser number of windings of relatively thicker copper wire. The mixing or agitating process is, in this instance, terminated upon the heating coils reaching their required operating temperature concurrent with the shutting-off of the current supply.

In lieu of the contact thermometer, in this particular switching circuit, a thermistor formed of, for example, an NTC-resistance, may be employed as temperature sensor 7, so as to render the immersion heater easier to manipulate. The voltage is reduced by means of a voltage divider 28, which is constructed so that no internal heating of the NTC-resistance 7 takes place.

In this case the triggering of thyristor 19 is somewhat more difficult since the operative efficiency of the immersion heater, upon the temperature at which a potentiometer 29 is approached, reaches only approximately 40 percent in response to the phase reduction.

Through the introduction of a corresponding RC-element 30, which is formed of one or more resistances 31 and at least one condensator 32, the operative efficiency may be raised to 85 percent and up to a maximum of 95 percent. Furthermore, the resistances 31 provide for a desirable decrease in the circuit voltage thereby reducing the load on thermistor 7 and providing protection for triggers 17 and 22. These latter may only be actuated by means of relatively low current intensities.

The phase cuts, however, cause intensive radio disturbances, particularly in the medium and high frequency range. In order to prevent the foregoing, transmission rectifying members must be incorporated, which generally consist of a transmission rectifying valve and condensators. These valves are, however, extremely large, and cannot be practically incorporated in the gripping device for the immersion heater.

Accordingly, referring now to the design of the connecting circuit in FIG. 11, in which the phase cutting angle is relatively small, the requirement for transmission rectifying members is eliminated. The thyristor 19 is herein completely switched. The schematic also includes a safety switching circuit 21. A thermistor is utilized as a second temperature sensor 7', having a control resistance 33 together with a potentiometer 29 for the control current circuit, mounted on a common axis therewith, so as to form a tandem-potentiometer 34. Clearly, the temperature sensor 7' and the control resistance 33 must be so coordinated with each other, to prevent the premature actuation of the safety switching circuit.

The trigger diode 35 which is utilized in safety switching circuit 21, and concurrently operative trigger diode 26 and thyristor 27 provided in the control current circuit, the flow of current in only one direction, and similarly does thyristor 36. Trigger diode 17 and alternating current thyristor 19 permit the flow of current in both directions. Consequently, a Zener diode 37 is required for the circuit, in accordance with FIG. 11, which shunts-off the negative voltage and concurrently provides for the stabilization of the control voltage. In order to provide for the stabilization while concurrently avoiding circuit voltage fluctuations, suitable voltage reference tubes, Zener reference diodes and the like may be employed in addition to Zener diode 37. This becomes necessary when it is desired to obtain temperatures in excess of 100° C, since at such higher temperatures the resistance changes of thermistors 7, and 7' are lessened, whereby the voltage deviations result in large temperature deviations.

In order to prevent internal heating of thermistors 7 and 7' these should not be excessively loaded, since any such heating of the thermistors will adversely affect the accuracy of the temperature control.

In order to provide protection for the apparatus, a high-speed safety installation 38 may be provided, which is adapted to cause the short-circuiting of the heating element. If thyristors only are utilized, it becomes advantageous to incorporate excess voltage shunts, for example, a transmission conduit 39. In general, however, the alternating current thyristors (Triacs), are designed so that upon excess voltages being sensed these are switched through without being triggered, and without being damaged thereby. However, thyristors may be damaged in the direction of closing, whereby they must be essentially designed that their closing voltage is higher than the transmission voltage of the Triacs.

Another embodiment of the temperature control is disclosed in FIG. 12 of the drawing, and essentially corresponds to the circuit diagram illustrated in FIG. 11. However, it is apparent that a contact thermometer 7' of the safety switching circuit, or a transistor 40 of the current control circuit may be utilized as the trigger for a pn-transmission. Furthermore, it is known that as a transistor-trigger it is particularly useful to utilize a transistor having a single transmission, a so-called Unijunction-Transistor (UJT). Again, as previously discussed, the safety switching circuit incorporates a thyristor 36, a resistance 24, and a thermal safety device incorporating the wire 25. The remaining elements of the safety circuit may correspond with those in FIG. 11, or reversely.

The transistor 40 replaces trigger diode 26 and receives a control voltage from point A. At point A the voltage is led at one side toward thermistor 7, and at the other side toward contact thermometer 7'. The advantage of this circuit lies in that between points C and D the voltage reaches only approximately 3 to 4 volts, thereby permitting the utilization of currently available thermistors. Furthermore, in lieu of using the NTC-resistances as thermistors, it is also possible to utilize resistors having positive temperature-coefficients (PTC-resistors). However it must be noted that in this instance, the thermistor 7 and the related potentiometer 29 must be reversed. This also applies to the safety switching circuit 21 in accordance with FIG. 11 for thermistor 7' and control resistance 33.

The various circuits may be utilized for all voltage ranges. However, individual elements, and particularly resistances 24, 28, 31 and thyristors 23, 27 and 36 must be selected in accordance with the predetermined operative voltage. Furthermore, the alternating current thyristor 19, the heat resistance of heating element 2 and the electrical coils for the drive of mixing device 8 must also be selected in conformance with the required operative parameters.

While there has been shown what is considered to be the preferred embodiment of the invention, it will be obvious that modifications may be made which come within the scope of the disclosure of the specification.

What is claimed is:

1. Immersion heater including an automatic temperature control; comprising a heating element adapted to be immersed in a fluid for heating thereof, and a fluid mixing device operatively connected to said heating element for imparting agitating motion to said heated fluid, said fluid mixing device comprising a circular plate member, said plate member being axially reciprocable in directions extending normal to the surface thereof.

2. Immersion heater as claimed in claim 1, comprising a source of electrical control current connected to said heating element, including temperature sensing means, the electrical control current flow to said element being responsive to said temperature sensing means, safety switch circuit means positioned in the electrical control current circuit of said heating element, said electrical control current circuit and said safety switch comprising a contactless switch including at least one thyristor, said thyristor having a trigger.

3. Immersion heater as claimed in claim 2, the electrical current supply to said heating element being controlled by the relationship between a variable current value responsive to said temperature sensing means and a predetermined operating current value, and at least one regulating resistance for determining said operating current value.

4. Immersion heater as claimed in claim 1, wherein said plate member comprises at least one nozzle aperture extending in the direction of movement of said plate member.

5. Immersion heater as claimed in claim 4, wherein said nozzle aperture comprises a tapered bore diameter extending along the length of said aperture.

6. Immersion heater as claimed in claim 4, wherein said nozzle aperture comprises an intermediate reduced-diameter orifice portion.

7. Immersion heater as claimed in claim 1, said fluid mixing device comprising an electrical induction coil, said induction coil including a movable iron core fastened to said plate member for imparting axial movement thereto in response to energization of said coil.

8. Immersion heater as claimed in claim 7, comprising a stationary iron core in proximate relationship with said movable iron core, said induction coil being rigidly fastened to said stationary iron core.

9. Immersion heater as claimed in claim 8, said stationary iron ore having a recessed portion, said movable iron core having portions thereof extending into said recessed core portion.

10. Immersion heater as claimed in claim 1, comprising means for imparting reverse axial movement to said plate member.

11. Immersion heater as claimed in claim 10, wherein said reverse movement imparting means comprises a membrane.

12. Immersion heater as claimed in claim 11, said membrane being formed of corrugated sheet metal.

13. Immersion heater as claimed in claim 9, comprising a membrane means connected to said plate member for imparting reverse axial movement thereto, receptacle means encompassing said induction coil and said movable and stationary iron cores, said membrane means comprising a cover fastened to said receptacle so as to form jointly therewith a sealed housing for said induction coil and said iron cores.

14. Immersion heater as claimed in claim 7, comprising a plurality of said plate members adapted to be axially moved in response to energization of said induction coil.

15. Immersion heater as claimed in claim 1, said heating element having an upper and a lower surface, said fluid mixing device being rigidly fastened to the upper surface of said heating element.

16. Immersion heater as claimed in claim 3, comprising a first one of said regulating resistance in the electrical control current circuit, and a second regulating resistance in said safety switch circuit means, said first and second resistances forming a tandem-potentiometer.

17. Immersion heater as claimed in claim 2, said thyristor trigger including a glow tube forming a control lamp.

18. Immersion heater as claimed in claim 2, said thyristor trigger comprising a contact thermometer.

19. Immersion heater as claimed in claim 2, said thyristor trigger comprising a transistor.

20. Immersion heater as claimed in claim 19, said transistor comprising a transistor having a single pn-transition.

21. Immersion heater as claimed in claim 2, comprising a condensator-type RC-element, and a resistance in said safety switch circuit means providing for instantaneous actuation of the trigger and thyristor.

22. Immersion heater as claimed in claim 2, comprising at least one resistance for reducing the circuit current intensity required for the safety switch circuit means actuating current.

23. Immersion heater as claimed in claim 2, comprising current stabilizers, current reference tubes, Zener reference diodes, and Zener diodes for reducing the operating circuit current intensities, and providing for elimination of current fluctuations.

24. Immersion heater as claimed in claim 2, comprising a low-temperature melting member, said member

of said safety switch, said member adapted to be melted upon heating during current flow so as to interrupt flow of current to said heating element.

25. Immersion heater as claimed in claim 2, comprising instantaneously-operative safety means in the current supply circuit of said heating element, said safety means shutting-off said heater by short-circuiting of said heating element.

* * * * *

Appeal Brief - Evidence Appendix C

Garrett, US 6,073,540

US006073540A

United States Patent [19]

Garrett

[11] **Patent Number: 6,073,540**

[45] **Date of Patent: Jun. 13, 2000**

[54] **APPARATUS FOR HEATING OR COOLING PRODUCT CONTAINERS**

[75] Inventor: **Robert A. Garrett**, Jackson, Calif.

[73] Assignee: **FMC Corporation**, Stockton, Calif.

[21] Appl. No.: **09/188,950**

[22] Filed: **Nov. 10, 1998**

[51] **Int. Cl.**[7] **A23L 1/00**; A23L 3/00; A23L 3/04; A23L 3/18; A47J 27/122

[52] **U.S. Cl.** .... **99/330**; 99/355; 99/360; 99/371; 99/404; 99/443 C; 99/470; 99/479; 99/483; 62/63; 62/374; 62/381

[58] **Field of Search** .... 99/330, 339, 340, 99/352–355, 359–371, 516, 404, 534, 536, 467, 468, 470, 477–479, 443 R, 443 C, 386, 483; 53/563, 379, 388, 576, 579; 34/216, 236; 62/63, 64, 374, 378, 380, 381; 165/120; 198/952, 752, 603; 426/405, 412, 510, 511, 520–523

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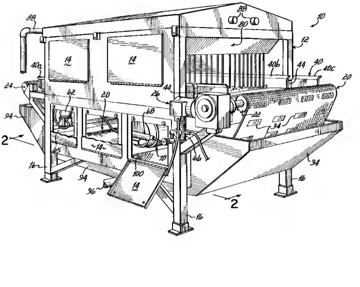
Primary Examiner—Timothy Simone
Attorney, Agent, or Firm—Wood, Herron & Evans, L.L.P.

[57] **ABSTRACT**

Apparatus and methods for transferring heat between a heat transfer liquid and a plurality of moving containers of food product. The containers are conveyed by a perforated conveyor at least partially submerged in a pool of the heat transfer liquid and are showered at the same time with the heat transfer liquid. The pool of heat transfer liquid continuously drains and recirculates through either a heater or a chiller. A vibrator unit vibrates the pool of heat transfer liquid, the conveyor and the containers during the heat transfer operation.

27 Claims, 5 Drawing Sheets



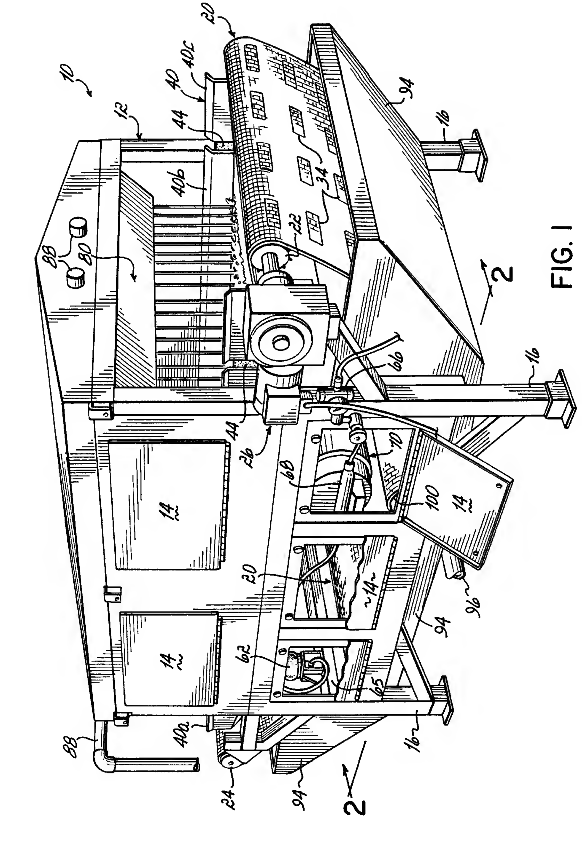


FIG. 1

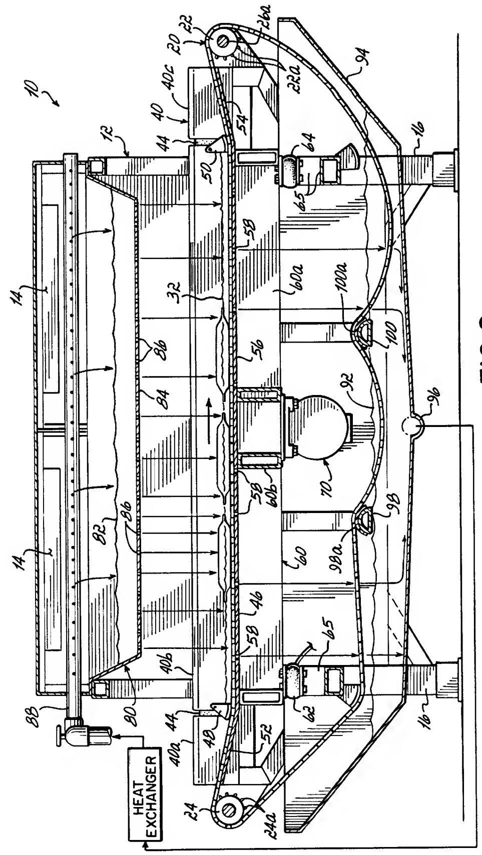


FIG. 2

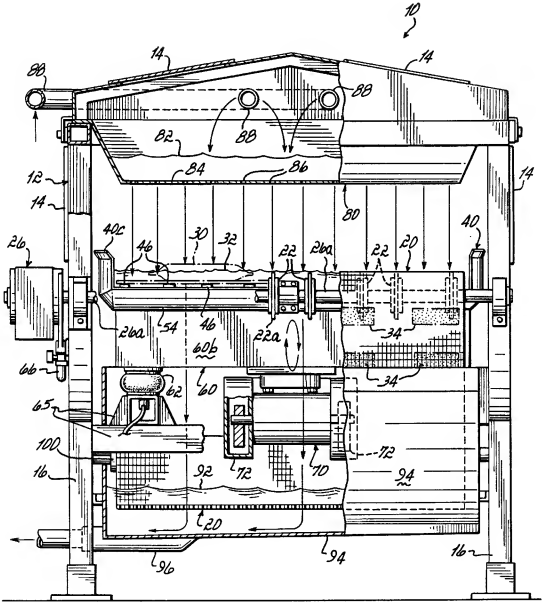

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FIG. 3

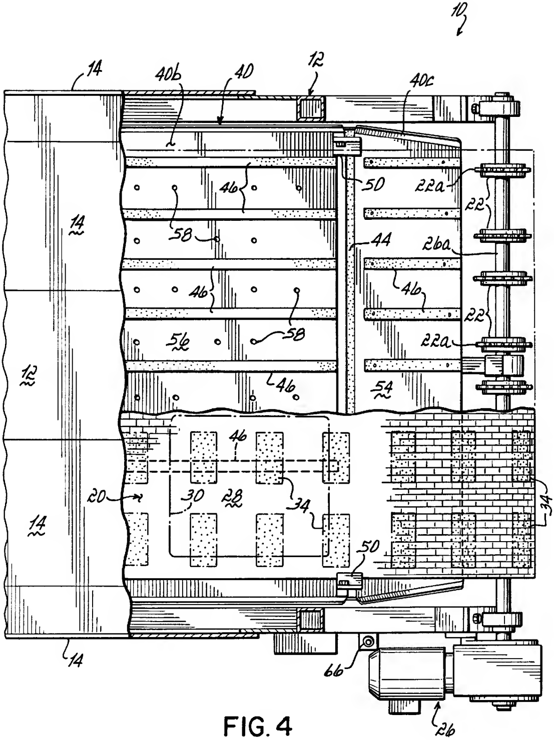
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FIG. 4

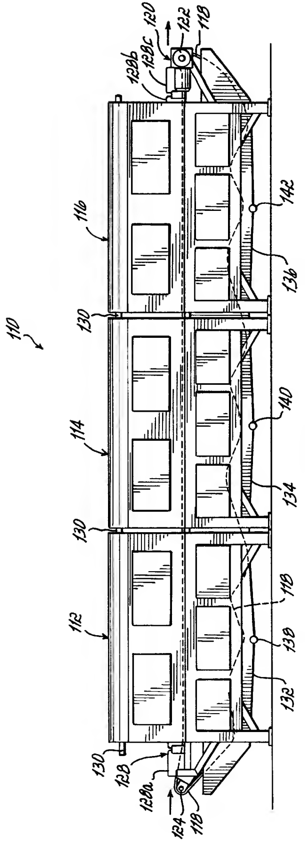
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FIG. 5

APPARATUS FOR HEATING OR COOLING PRODUCT CONTAINERS

FIELD OF THE INVENTION

The present invention generally relates to heat exchange systems and, more specifically, to apparatus and methods for heating or cooling product containers, for example, filled with liquid-based food product.

BACKGROUND OF THE INVENTION

In many food processing operations, such as in the processing of fruit and vegetable products, the food product must be heated and maintained at a sterilizing temperature and then cooled sufficiently to allow further packaging and transport. After proper heat sterilization, the product is either cooled and then packaged under aseptic conditions, or the product is immediately packaged in a heated, sterile condition and then cooled to a temperature sufficient for additional packaging and shipping. The product may also be packed cold in a container, and then sealed, sterilized and cooled in the container. Cooling the sterilized food product while the product is sealed within a container, such as a flexible bag, eliminates the need for filling sterile bags with cooled, sterile food product under aseptic conditions. Instead, the bag may be filled with heated, sterilized food product and sealed to ensure that the food product remains sterile. To achieve acceptable cooling times, complex cooling equipment has generally been designed to accommodate specific package types. On the other hand, simpler conveying systems that merely spray the packages with chilled liquid result in longer cooling times and, therefore, higher processing costs.

Many different systems have been proposed and used for continuously heating and/or cooling containers of food product along a moving production line. As mentioned above, some of the more complex systems include mechanisms or structure for agitating the food contents as the containers are heated or cooled by liquid or gas heat transfer media. For example, cans of liquid-based food product have been agitated back and forth or rolled as a conveyor moves the cans past nozzles that spray the cans with a heat transfer liquid. With other equipment, pouches or bags have been manipulated by rollers or rocked back and forth on specialized carriers while the pouches are conveyed through a heat transfer media.

To address various problems of the past, it would be desirable to provide apparatus and methods for heating and/or cooling product quickly and uniformly, whether the product is packaged in a rigid or flexible container.

SUMMARY OF THE INVENTION

The present invention therefore generally provides apparatus for transferring heat between a heat transfer liquid and a plurality of flexible or rigid containers filled at least partially with food product. The apparatus may comprise essentially one module or a series of modules linked to form a longer system. The apparatus generally comprises a perforated conveyor having a conveying surface for supporting the containers and transferring the containers through a housing structure. A conveyor pan receives the perforated conveyor and includes an open top portion and at least one drain. The conveyor pan holds a continuously recirculating pool of heat transfer liquid at a level disposed above the conveying surface of the perforated conveyor. In this manner, heat is transferred between the pool of heat transfer liquid and the contents of the containers. In addition, a heat

transfer liquid distributor is spaced above the perforated conveyor and showers the containers with heat transfer liquid directed through the open top portion of the conveyor pan. This effects further heat transfer between the showering liquid and the contents of the containers. Finally, a vibrator unit is operatively connected with the conveyor pan and vibrates the conveyor pan, the perforated conveyor, the pool of heat transfer liquid and the containers of food product as the containers are moved by the conveyor. Uniform, efficient heat transfer therefore occurs between the heat transfer liquid and the food product in the containers. The apparatus accomplishes this result while also being easily incorporated into existing processing operations and being versatile enough to accommodate a wide variety of container sizes and types.

In the preferred embodiment, a conveyor support contacts the perforated conveyor and is mounted along a bottom surface of the perforated conveyor pan to transmit vibrations between the vibrator unit and the perforated conveyor. A liquid return pan is mounted below the conveyor pan for receiving the heat transfer liquid from the drain. The liquid is drained in a continuous manner or, in other words, in a manner which maintains a predetermined liquid pool level that partially submerges the containers moving along the conveyor. The drain of the conveyor pan preferably comprises multiple perforations in a lower surface of the conveyor pan. These perforations generally occupy an area opposed to the conveying surface such that the pool of heat transfer liquid drains across the conveying surface in a generally uniform manner. The perforated conveyor is a continuous conveyor that has a lower portion passing through the liquid return pan. The perforated conveyor additionally includes a plurality of high friction elements on the conveying surface for maintaining the containers in contact with the perforated conveyor and moving through the pool of liquid. Other structure may be provided for this purpose in addition or as an alternative to the high friction elements.

The housing structure includes an inlet end and an outlet end and the perforated conveyor is more specifically a flexible belt having portions disposed generally at the inlet and outlet ends. Guide elements contact these portions of the belt and direct the belt downwardly into the conveyor pan. The liquid distributor is preferably a liquid distributing pan adapted to hold a volume of the heat transfer liquid. The liquid distributor pan includes a lower, perforated surface generally occupying an area opposed to and covering the conveying surface of the perforated conveyor. Therefore, the liquid distribution pan uniform ly showers the containers on the conveying surface with chilled or heated liquid. A heat exchanger receives the heat transfer liquid in a recirculation path generally between the conveyor pan and the liquid distributor pan to continuously heat or cool the liquid. Finally, a plurality of pneumatic vibration dampeners are mounted between the housing structure and the conveyor p an and, more preferably, between a conveyor pan support structure and the conveyor pan. These devices isolate vibrations of the conveyor pan from the remaining portions of the housing structure, and provide height adjustment to maintain the conveyor pan at optimum operational height.

The invention is also directed to methods for effecting heat transfer between a plurality of containers filled with food product and a heat transfer liquid. These methods may be performed using apparatus as generally described above, and involve moving the plurality of containers along a perforated conveyor which is positioned to partially submerge the containers within a pool of the heat transfer liquid.

Heat transfer liquid showers the containers as they move along the perforated conveyor. The pool of heat transfer liquid is drained to maintain a level that partially submerges the containers. Finally, the perforated conveyor, the pool of heat transfer liquid, and the containers are vibrated during the conveying and showering operation to agitate the product within the container and effect more uniform heat transfer.

Various additional objects, advantages and features of the invention will become more readily apparent to those of ordinary skill in the art upon review of the following detailed description of the preferred embodiment taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an apparatus constructed in accordance with the preferred embodiment;

FIG. **2** is a cross sectional view taken generally along line **2**—**2** of FIG. **1**;

FIG. **3** is a partially fragmented end view of the apparatus shown in FIG. **1**;

FIG. **4** is a partially fragmented top view of the apparatus shown in FIG. **1**; and

FIG. **5** is a side elevational view showing a longer heat exchange system linking together several heat transfer modules constructed according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIGS. **1**–**4**, an apparatus **10** constructed in accordance with the preferred embodiment includes a housing structure **12**. It will be appreciated that apparatus **10** may take on many different forms in accordance with this invention, however, one useful form is that of a module which is useful alone or linked with like modules to form a longer heat transfer path, as will be appreciated from the description to follow. Housing structure **12** may include a plurality of access panels **14** and may generally include various types of frame structure **16** for support purposes.

Apparatus **10** more specifically includes a perforated conveyor belt **20**, which may be formed from any suitable perforated material or structure allowing a heat transfer liquid to flow through the conveyor. One suitable conveyor belt is sold under No. 1S62051S-HA-HF, obtainable from KVP/Falcon, located in Rancho Cordova, Calif. Perforated conveyor belt **20** is preferably a continuous conveyor belt which moves from left to right, as viewed in FIG. **2**, over respective wheels **22**, **24**. Wheels **22**, **24** have projections **22***a*, **24***a* that engage the perforations or other spaces within belt **20**. A suitable drive assembly **26**, which may comprise a conventional motor and gear drive, is connected to wheels **22** by a drive shaft **26***a* for driving perforated conveyor belt **20** in a clockwise direction, as viewed in FIG. **2**. Wheels **24** act as idler wheels to guide the opposite end of conveyor **20**. As further shown in FIG. **2**, perforated conveyor belt **20** includes a conveying surface **28** receiving a plurality of pouches **30** containing food product, such as liquid-based fruit or vegetable product. Pouches **30** ride along conveying surface **28** while being partially submerged within a pool **32** of heat transfer liquid. Liquid pool **32** may comprise either a heated liquid or a chilled liquid depending on whether a heating or a cooling operation is being performed by apparatus **10**. Also, although apparatus **10** is particularly useful for effecting heat transfer to or from pouches **30**, more rigid containers may also be processed with apparatus **10**. Preferably, pouches **30** are only about half submerged in liquid pool **32**, as shown in FIG. **2**, to prevent pouches **30** from floating or losing substantial contact with conveying surface **28**. To further promote engagement of pouches **30** with conveying surface **28**, conveying surface **28** preferably includes a plurality of high friction elements **34**, as best shown in FIG. **1**. These may be replaced or augmented with additional engagement structure, such as upstanding members, for maintaining the movement of pouches **30** with conveyor belt **20**.

Perforated conveyor belt **20** is contained within and supported by a conveyor pan **40**. In this preferred embodiment, conveyor pan **40** includes three sections, namely, an inlet section **40***a*, an intermediate section **40***b*, and an outlet section **40***c*. Inlet and outlet sections **40***a*, **40***c* are each sloped upwardly to contain the pool of liquid **32** within conveyor pan **40**. Rubber connecting material **42**, **44** may affix inlet and outlet sections **40***a*, **40***c* to respective ends of intermediate section **40***b* in a fluid-tight manner. One suitable rubber connecting material is available from Godiva Rubber Company, located in San Mateo, Calif. A plurality of skid bars **46**, or other types of support members, are affixed to the lower, interior surface of conveyor pan **40** to allow perforated conveyor belt **20** to ride in contact with conveyor pan **40**. Respective shoes **48**, **50** hold conveyor belt **20** down against respective bottom walls **52**, **54**, **56** of conveyor sections **40***a*, **40***b*, **40***c*. More specifically, conveyor belt **20** is held against skid bars **46**. Bottom wall **56** of intermediate conveyor pan section **40***b* includes a plurality of perforations **58** preferably spread across the entire width of conveyor belt **20** and extending along thee length of intermediate conveyor pan section **40***b* for uniformly draining conveyor pan **40** in a continuous manner. A conveyor support **60**, which may be in the form of a frame structure having perpendicularly affixed frame members **60***a*, **60***b*, supports conveyor pan **40**, and the liquid pool **32** and pouches **30** during operation. A plurality of pneumatic vibration dampeners **62**, **64** (FIG. **2**) are provided between conveyor support **60** and other support members **65** of housing structure **12**. These isolate vibrations of conveyor pan **40** and support **60** from other portions of housing structure **12** and provide height adjustment to maintain conveyor pan **40** and support **60** at optimum operational height. Suitable pneumatic vibration dampeners may be obtained from Firestone, located in Carmel, Ind. Conventional pneumatic controls **66**, which may include an air accumulator **68**, are connected to operate pneumatic vibration dampeners **62**, **64**. At least one vibrator unit **70** is connected to the underside of conveyor support **60** and vibrates conveyor pan **40**, perforated conveyor belt **20**, the pool **32** of heat transfer liquid and pouches **30** during operation. A suitable vibrator unit may be obtained as Model BK 40-35/4 from Invicta, located in Charleston, S.C. As shown in FIG. **3**, vibrator unit **70** may include eccentric, rotated weights **72** to produce vibrations which are ultimately transmitted to the pool **32** of liquid and to pouches **30**.

A liquid distributor pan **80** is mounted above intermediate conveyor pan section **40***b* and holds a supply **82** of freshly chilled or heated liquid. Liquid distributor pan **80** also includes bottom surface **84** having perforations **86** and extending across substantially the entire length and width of the portion of conveyor belt **20** riding within conveyor pan section **40***b*. Pouches moving in this area therefore receive a shower of freshly chilled or heated liquid **82**. Liquid distributor pan **80** is filled, preferably in a continuous manner, by one or more conduits **88**. Conduits **88** receive liquid **82** from a heat exchanger **90** which may be a heater

or a chiller. As shown in FIG. **2**, heat exchanger **90** receives heat transfer liquid **92** from a lower liquid return pan **94** through a drain **96**. Liquid return pan **94** is mounted to housing structure **12** and disposed directly below conveyor pan **40** to receive the liquid which continuously drains from pool **32**. This liquid drains continuously between the frame members **60***a*, **60***b* of conveyor pan support **60**. As also shown in FIG. **2**, perforated conveyor belt **20** loops back through liquid return pan **94** and is guided over frame members **98**, **100**, which may have rounded upper surfaces with low friction pads or surfaces **98***a*, **100***a*.

FIG. **5** illustrates a longer system **110** for heating or cooling product containers in essentially the same manner as apparatus **10** described with respect to FIGS. **1–4**. System **110** may include multiple modules **112**, **114**, **116** that operate as described with respect to apparatus **10** above. In system **110**, a single perforated conveyor belt **118** extends through each module **112**, **114**, **116** and is rotated by a single drive **120** connected with conveyor drive wheels **122**. Like apparatus **10**, idler wheels **124** are disposed at the opposite end of system **110**. A conveyor pan **128** having inlet, intermediate, and outlet sections **128***a*, **128***b*, **128***c* extends through modules **112**, **114**, **116**. One or more conduits **130** supply heat transfer liquid to the interior of modules **112**, **114**, **116** in the same manner as discussed above. These may supply the heat transfer liquid to liquid distributor pans (not shown) respectively mounted within modules **112**, **114**, **116**. Each module **112**, **114**, **116** includes a liquid return pan **132**, **134**, **136**, each having a drain **138**, **140**, **142**. Drains **138**, **140**, **142** may be connected with one or more heat exchangers in a recirculation path leading back to supply conduits **130**, as discussed with respect to FIGS. **1–4**. It will be appreciated that system **110** may include more or less modules than the three shown in FIG. **5**. The specific size of system **110** will depend, for example, on the heat transfer requirements, the quantity of given units over time, and size requirements of the individual product containers processed by system **110**.

As one additional example of heat exchanging apparatus that may be constructed in accordance with the invention, one or more apparatus **10** and/or apparatus **110** may be combined in a heating and cooling operation. For example, one apparatus **10** or **110** may be used initially to heat and sterilize pouches **30** or other containers of product, while another apparatus **10** or **110** may be positioned at the outlet thereof to receive the pouches **30** or other containers for a subsequent cooling operation. In each stage of the process, apparatus **10** and **110** may be utilized in essentially the same manner as described above, with heated liquid being used in the sterilizing section and chilled liquid being used in the cooling section. If desired or necessary for some applications, apparatus constructed according to the invention may include additional heating or cooling elements. Also, apparatus of the invention may be used in conjunction with other heating or cooling apparatus depending on the applications.

The basic operation of apparatus **10**, system **110**, or a combined heating and cooling system, may be understood with reference to FIGS. **1** and **2**. In this regard, product containers **30** are received on conveyor belt **20** at the left end or inlet end of housing **12**. These product containers, which may be flexible pouches or bags **30**, travel downwardly on conveyor **20** along bottom wall **52** of conveyor pan section **40***a* until they are partially submerged within a pool **32** of heat transfer liquid. Pouches **30** then travel horizontally through liquid pool **32** on conveyor belt **20** as it moves through intermediate section **40***b* of conveyor pan **40**. Pool **32** of heat transfer liquid is supplied continuously by liquid showering into conveyor pan **40** from the supply **82** of liquid contained in liquid distributor pan **80**. More particularly, this liquid continuously drains through perforations **86** contained in the bottom of distributor pan **84**. This liquid supply **82** is continuously replenished from a heat exchanger **90** which may supply freshly chilled or heated liquid through conduits **88**. The pool **32** of liquid contained in conveyor pan **40** is also continuously drained through perforations **58** contained throughout the bottom surface **56** of conveyor pan **40**. This liquid drains into liquid return pan **94** and is eventually recirculated back to heat exchanger **90**. While product containers **30** are conveyed along the bottom surface of conveyor pan **40**, the vibrator unit **70** operates to continuously vibrate conveyor support **60**, conveyor pan **40**, the portion of conveyor **20** within conveyor pan **40**, the pool **32** of heat transfer liquid and, finally, product containers **30** and the product contained therein. Product containers **30** then exit housing structure **12** at the outlet end or right end thereof, as viewed in FIGS. **1** and **2**. Apparatus **10** thereby provides fast, thorough heat transfer between the heat transfer liquid and the contents of product containers **30** while moving containers on to further packaging operations.

As one example of the potential results of apparatus **10**, prior conveying apparatus which simply included spraying the pouches of product with chilled water required **30** minutes of cooling treatment to reduce a 1½ gallon bag of ketchup from an input temperature of 190° F. to an output temperature of 100° F. using 33° F. water as the cooling liquid. The same apparatus takes 46–48 minutes to reduce the same item from 190° F. to 100° F. using 75° F.–85° F. water as the heat transfer liquid. In contrast, a system constructed in accordance with the invention takes 14 minutes for the same item to be reduced in temperature from 190° F. to 100° F. using 50° F. water as the heat transfer liquid and takes 20 minutes for the same temperature reduction using 77° F. water as the heat transfer liquid.

While the present invention has been illustrated by a description of a preferred embodiment and while this embodiment has been described in some detail, it is not the intention of the Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. This has been a description of the present invention, along with the preferred methods of practicing the present invention as currently known. However, the invention itself should only be defined by the appended claims, wherein I claim:

1. Apparatus for transferring heat between a heat transfer liquid and a plurality of product containers, the apparatus comprising:

a perforated conveyor having a conveying surface for supporting and transferring the containers;

a conveyor pan receiving the conveying surface of the perforated conveyor and including an open top portion and at least one drain, the conveyor pan being adapted to hold a continuously recirculating pool of the heat transfer liquid at a level disposed above the conveying surface of the perforated conveyor;

a heat transfer liquid distributor spaced above the perforated conveyor and operative to shower the containers on the conveying surface with the heat transfer liquid by directing the heat transfer liquid through the open top portion of the conveyor pan; and

a vibrator unit operatively connected with the conveyor pan and operating to vibrate the conveyor pan, the perforated conveyor, the pool of heat transfer liquid and the containers as the containers are moved by the perforated conveyor to thereby uniformly and effi-

ciently transfer heat between the heat transfer liquid and the product in said containers.

2. The apparatus of claim 1 further comprising:

a conveyor support in contact with the perforated conveyor and mounted along a bottom surface of the perforated conveyor pan to transmit vibrations to the perforated conveyor.

3. The apparatus of claim 1 further comprising a liquid return pan mounted below the conveyor pan for receiving the heat transfer liquid from the drain.

4. The apparatus of claim 3, wherein the drain of said conveyor pan further comprises multiple perforations in a lower surface of the conveyor pan and generally occupying an area opposing the conveying surface such that the pool of heat transfer liquid drains generally in a uniform manner.

5. The apparatus of claim 3, wherein the perforated conveyor further comprises a continuous conveyor, and the continuous conveyor passes through the liquid return pan.

6. The apparatus of claim 1, wherein the perforated conveyor further includes a plurality of container engagement elements that maintain the containers moving along the perforated conveyor and through the pool of liquid.

7. The apparatus of claim 1, wherein the perforated conveyor is a continuous conveyor belt, and further including guide elements mounted in contact with the conveyor belt and directing the conveyor belt downwardly into the conveyor pan.

8. The apparatus of claim 1, wherein the liquid distributor is a liquid distributing pan adapted to hold a volume of the heat transfer liquid and having a lower, perforated surface generally occupying an area opposing the conveying surface such that the perforated surface can shower the conveying surface with the heat transfer liquid.

9. The apparatus of claim 1 further comprising:

a heat exchanger having an inlet connected for fluid communication with the drain of said conveyor pan and including an outlet connected for fluid communication with said liquid distributor such that a recirculation path is formed between the conveyor pan and the liquid distributor.

10. The apparatus of claim 9, wherein the heat exchanger is a device for cooling the heat transfer liquid.

11. The apparatus of claim 9, wherein the heat exchanger is a device for heating the heat transfer liquid.

12. The apparatus of claim 1, wherein the conveyor pan is disposed in a housing structure and further comprising a plurality of pneumatic vibration dampeners mounted between the housing structure and the conveyor pan to isolate vibrations of the conveyor pan from remaining portions of the housing structure.

13. The apparatus of claim 12 further comprising a conveyor pan support structure mounted between the pneumatic vibration dampeners and the conveyor pan.

14. The apparatus of claim 12, wherein the pneumatic vibration dampeners are height adjustable to change the height of said conveyor pan.

15. Apparatus for transferring heat between a heat transfer liquid and a plurality of product containers, the apparatus comprising:

a perforated conveyor having a conveying surface for supporting and transferring the containers;

a conveyor pan receiving the conveying surface of the perforated conveyor and including an open top portion and a perforated bottom wall, the conveyor pan being adapted to hold a continuously recirculating pool of the heat transfer liquid at a level disposed above the conveying surface of the perforated conveyor;

a heat transfer liquid distributor pan mounted above said perforated conveyor and having an interior and a perforated lower surface spaced above the perforated conveyor, said liquid distributor pan adapted to hold a supply of said heat transfer liquid in the interior and the perforated lower surface operating to shower the containers on the conveying surface with the heat transfer liquid by directing the heat transfer liquid through the open top portion of the conveyor pan;

a liquid supply conduit in fluid communication with the interior of the liquid distributor pan; and

a vibrator unit operatively connected with the conveyor pan for vibrating the conveyor pan, the perforated conveyor, the pool of heat transfer liquid and the containers as the containers are moved by the perforated conveyor to thereby uniformly and efficiently transfer heat between the heat transfer liquid and the product in said containers.

16. The apparatus of claim 15 further comprising:

a conveyor support in contact with the perforated conveyor and mounted along a bottom surface of the perforated conveyor pan to transmit vibrations to the perforated conveyor.

17. The apparatus of claim 15 further comprising a liquid return pan mounted below the conveyor pan for receiving the heat transfer liquid from the drain.

18. The apparatus of claim 17, wherein the drain of said conveyor pan further comprises multiple perforations in a lower surface of the conveyor pan and generally occupying an area opposing the conveying surface such that the pool of heat transfer liquid drains generally in a uniform manner.

19. The apparatus of claim 17, wherein the perforated conveyor further comprises a continuous conveyor, and the continuous conveyor passes through the liquid return pan.

20. The apparatus of claim 15, wherein the perforated conveyor further includes a plurality of high friction elements that maintain the containers moving along the perforated conveyor and through the pool of liquid.

21. The apparatus of claim 15, wherein the perforated conveyor is a continuous conveyor and further including guide elements mounted in contact with the conveyor and directing the conveyor downwardly into the conveyor pan.

22. The apparatus of claim 15, wherein the liquid distributor is a liquid distributing pan adapted to hold a volume of the heat transfer liquid and having a lower, perforated surface generally occupying an area opposing the conveying surface such that the perforated surface can shower the conveying surface with the heat transfer liquid.

23. The apparatus of claim 15 further comprising:

a heat exchanger having an inlet connected for fluid communication with the drain of said conveyor pan and including an outlet connected for fluid communication with said liquid distributor such that a recirculation path is formed between the conveyor pan and the liquid distributor.

24. The apparatus of claim 23, wherein the heat exchanger is a device for cooling the heat transfer liquid.

25. The apparatus of claim 23, wherein the heat exchanger is a device for heating the heat transfer liquid.

26. The apparatus of claim 15, wherein the conveyor pan is disposed in a housing structure and further comprising a plurality of pneumatic vibration dampeners mounted between the housing structure and the conveyor pan to isolate vibrations of the conveyor pan from remaining portions of the housing structure.

27. The apparatus of claim 26 further comprising a conveyor pan support structure mounted between the pneumatic vibration dampeners and the conveyor pan.

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(x) Related Proceedings Appendix

None.